Unit VIII (C)

COURSE TITLE Building Design for Homeland Security for Continuity of Operations (COOP) Train-the-Trainer **TIME** 75 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 system efficacy relative to the particles present in CBR 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

1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*, Chapter 5
2. FEMA 426, *Appendix C*, Chemical, Biological, and Radiological Glossary
3. FEMA 453, *Design Guidance for Shelters and Safe Rooms*, Chapters 1 and 3
4. Case Study – Appendix C: COOP, Cooperville Information / Business Center
5. Student Manual, Unit VIII (C) (info only – not listed in SM)
6. Unit VIII (C) visuals (info only – not listed in SM)

REQUIREMENTS

1. FEMA 426, *Reference Manual to Mitigate Potential Terrorist Attacks Against Building*s (one per student)
2. Instructor Guide, Unit VIII (C)
3. Student Manual, COOP Case Study (C) (one per student)
4. Overhead projector or computer display unit

5. Unit VIII (C) visuals
6. Chart paper, easel, and markers (one per team)

UNIT VIII (C) OUTLINE

PREPARING TO TEACH THIS UNIT

- **Tailoring Content to the Local Area:** This is a generic instruction unit that does not have any specific capability for linking to the Local Area. However, Units IX, Site and Layout Design Guidance, and X, Building Design Guidance are excellent opportunities to illustrate the concepts in this instruction unit as applied to the Local Area.

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

- **Activity:** The students will answer questions in the Student Activity exercises using the Case Study to identify prevalent CBR threats (Design Basis Threat and others) and using FEMA 426 to answer selected filtration and mitigation measure questions.

- Refer students to their Student Manuals for worksheets and activities.

- Direct students to the appropriate page (Unit #) in the Student Manual.

- Instruct the students to read the activity instructions found in the Student Manual.

- Tell students how long they have to work on the requirements.

- While students are working, all instructors should closely observe the groups' process and progress. If any groups are struggling, immediately assist them by clarifying the assignment and providing as much help as is necessary for the groups to complete the requirement in the allotted time. Also, monitor each group for full participation of all members. For example, ask any student who is not fully engaged a question that requires his/her viewpoint to be presented to the group.

- At the end of the working period, reconvene the class.

- After the students have completed the assignment, "walk through" the activity with the students during the plenary session. Call on different teams to provide the answer(s) for each question. Display the charts applicable to the respective question to illustrate the answer.

- If time is short, simply provide the "school solution" and ask for questions. Do not end the activity without ensuring that students know if their answers are correct or at least on the right track.

- Ask for and answer questions.

Editor Note: Two methods have been used in Instructor Guides to ensure the slide designation and slide thumbnail in the left column aligns with the Content/Activity in the right column.

(1) Highlight row by placing cursor in left column until arrow shifts to right, Tab <Insert>, <Break>, <select Page Break>, <OK>

(2) Highlight row as in (1), right click on highlighted row for menu, <Table Properties>, Tab <Row>, remove check in box <Allow row to break across pages>

(3) Alternate for (2), highlight row, click on <Table> at top of screen, <Table Properties> and continue like (2)

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INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

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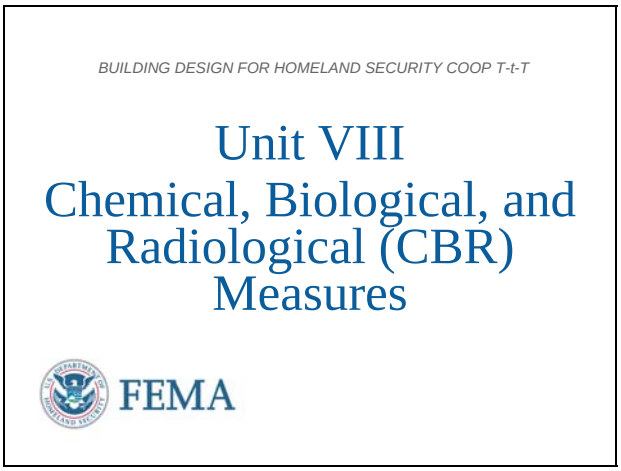
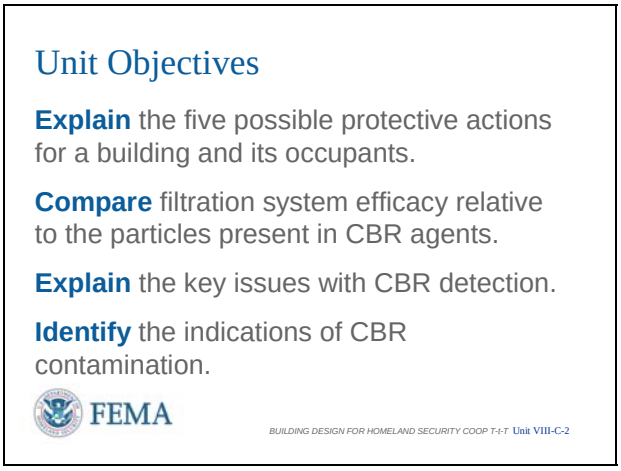


VISUAL VIII-C-2



Introduction and Unit Overview

This is Unit VIII 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.

NOTE to instructor: Do not dwell upon the technical nature of CBR up to Visual VIII-C-41. Go over this front end quickly. Then concentrate on the mitigation measures in C-41 and beyond. However, actual incidents could receive additional explanation to better understand the threat.

Unit Objectives

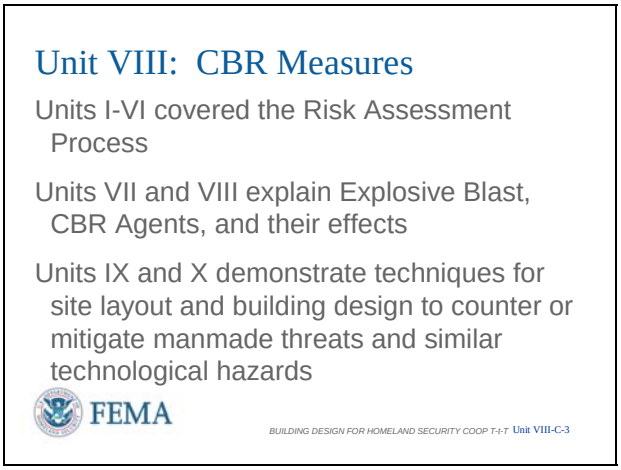
At the end of this unit, the students should be able to:

1. Explain the five possible protective actions for a building and its occupants.
2. Compare filtration system efficacy relative to the particles present in CBR agents.
3. Explain the key issues with CBR detection.
4. Identify the indications of CBR contamination.

NOTE to instructor: Emphasize that if your COOP facility's threats and hazards include CBR as nearby Hazardous Material or as Terrorist Attack, then this instruction unit provides what you need to know to make an initial assessment.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-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. The following will be discussed:

- Evacuation
- Sheltering in place
- Personal protective equipment
- Air filtration and pressurization
- Exhausting and purging
- CBR detection

Additionally, CBR design and mitigation measures are discussed in:

- **Chapter 3 of FEMA 426**
- **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.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-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.

Chapter 5 of FEMA 426 provides an overview on CBR Detection and Current Technology; and Indications of CBR Contamination, Evacuation, Sheltering in Place, Air Filtration and Pressurization, and Exhausting and Purging.

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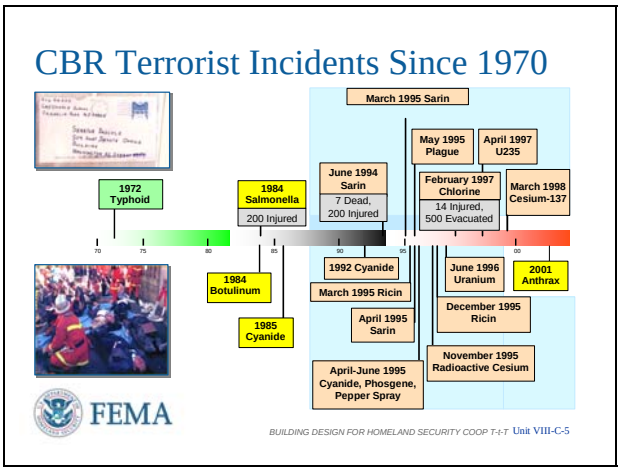

CBR Terrorist Incidents Since 1970

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.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

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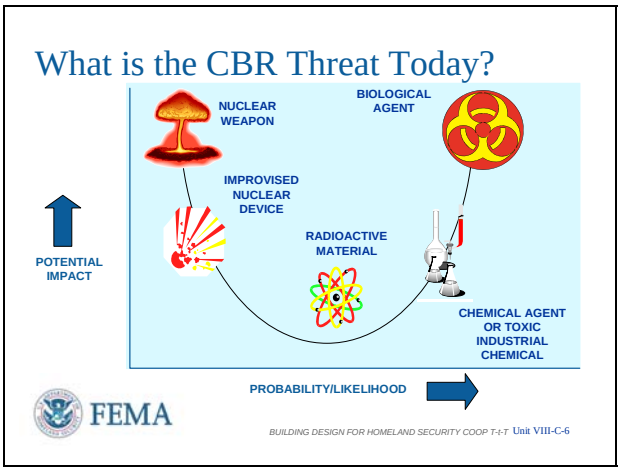

What is the CBR Threat?

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.

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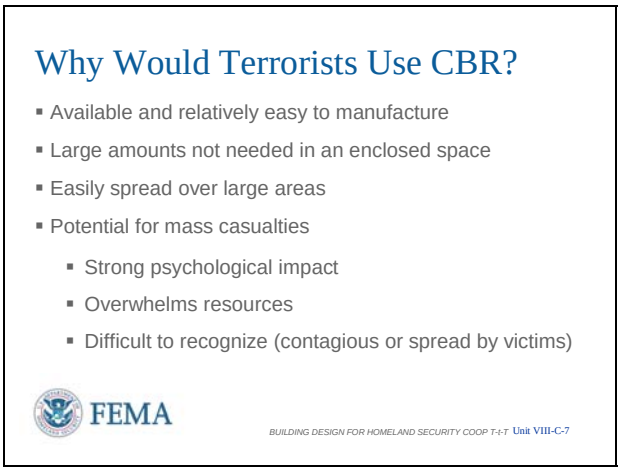

Why Would Terrorists Use CBR?

- Available and relatively easy to manufacture
- Large amounts not needed in an enclosed space
- Easily spread over large areas
- Potential for mass casualties
  - Strong psychological impact
  - Overwhelms resources
  - Difficult to recognize (contagious or spread by victims

Recent events have shown that people not directly affected by the attack, but nearby, will seek medical confirmation of health / non-contamination and quickly overwhelm medical resources.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

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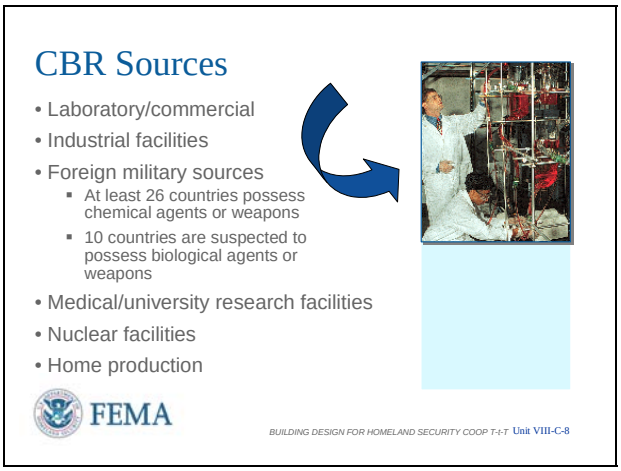

CBR Sources

There are many potential sources of chemical and biological agents, including laboratory and commercial production; and home production in those cases involving low concentrations of 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.**

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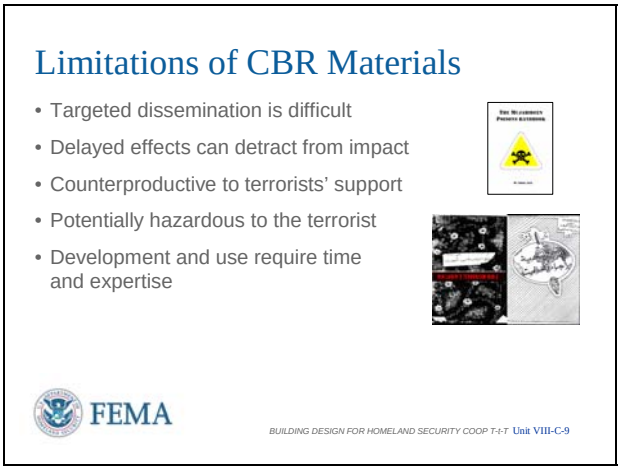


Limitations of CBR Materials

- Targeted dissemination is difficult. While agents can be spread over a wide area with relative ease, targeting with sufficient concentration is much more difficult.
- Delayed effects can detract from impact. Terrorist seek immediate media impact, but many agents take time to result in impact
- Counterproductive to terrorists' support. Indiscriminate use of any WMD (Weapon of Mass Destruction), especially ones difficult to target with success, can attack innocents and those in the support base, thus reducing support of the populace for the terrorists' objectives.
- Potentially hazardous to the terrorist. Lack of expertise among terrorists can result in deadly contact with the CBR agents being produced, or premature

The slide shows the cover of Ben Laden's Terrorism Bible and The Mujahideen Poisons Handbook by Abdel Aziz. "Majahideen" - Arabic word meaning "holy warriors." This book is part of the Encyclopedia Jihad. The aim of this book is to further the military/ political preparations, skills and knowledge of Mujahideen the world over.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

explosion of bombs during the bomb making process with deadly consequences

- Development and use require skill. More than one terrorist has produced bombs that will not explode and CBR agents that will not impact upon human beings to the level desired.

VISUAL VIII-C-10

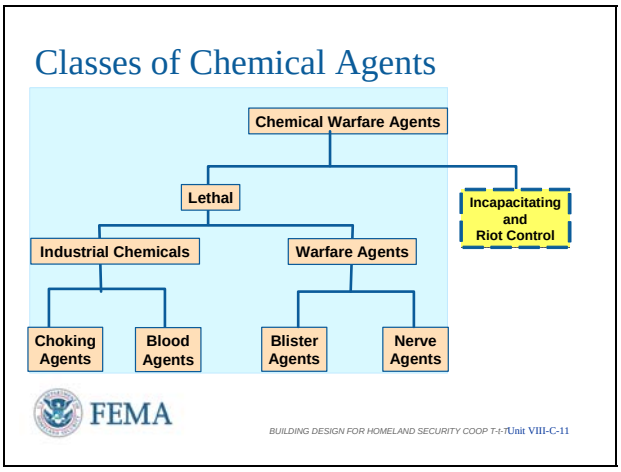
Subway riders injured in Aum Shinrikyo Sarin gas attack, in Tokyo, March 20, 1995.

Chemical Agents: Characteristics and Behavior

These are the general characteristics of chemical agents

- Liquids that are spread as aerosols or gases
- Impact breathing and attack exposed skin
- May have a distinct odor that allow detection
- Greatly influenced by the weather – rain, wind, sunlight, including its own physical characteristics – heavier or lighter than air

VISUAL VIII-C-11



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**: 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.

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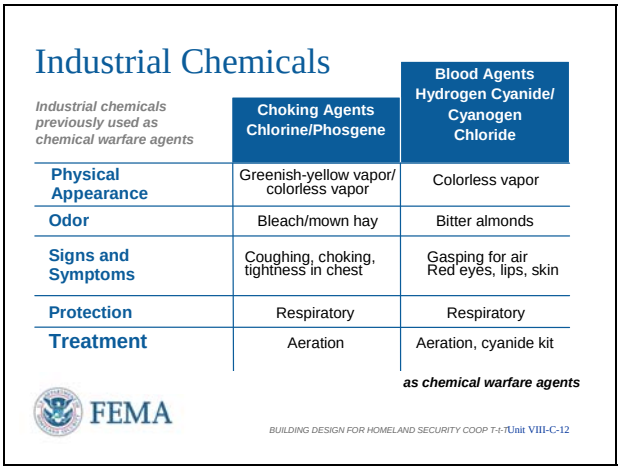

Industrial Chemicals

This chart lists four industrial chemicals that were previously used as chemical warfare agents. These chemicals are used in the:

- Sanitation industry
- Plastics industry
- 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)).

Skin contact with concentrated material may cause chemical burns and contact with eyes has similar effects as indicated by the MSDS (Material Safety Data Sheets) for these chemicals. However the main tactic for use of these chemicals does not seek this effect.

They are all exceedingly volatile and dissipate rapidly outdoors.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

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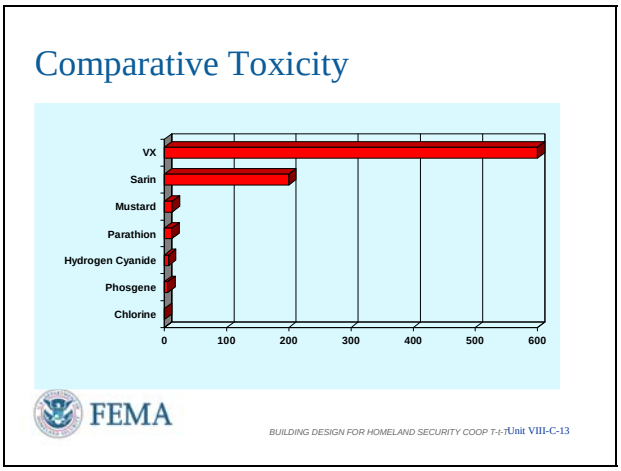


Note: At this point, reinforce the following: *…as we collectively examine and identify opportunities to improve building safety from CBR, it is important to understand the characteristics of CBR, and their potential consequences for the public, and first responders…. detailed information on the properties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

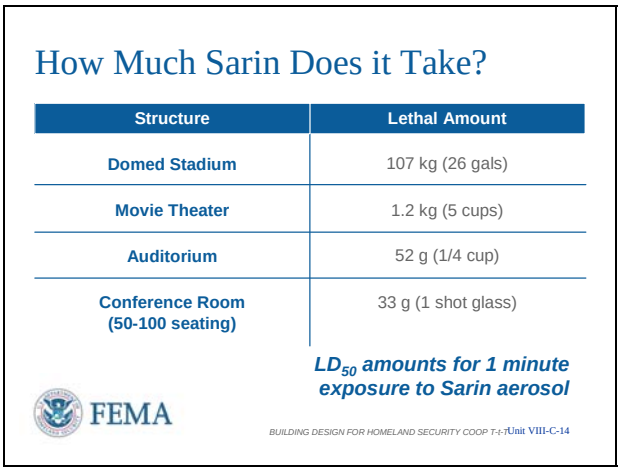
Comparative Toxicity

This is a graphical comparison of the approximate lethalities of some chemical agents. They are based relative to Chlorine (CL or Cl) 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 (nerve agent) 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.

VISUAL VIII-C-14



How Much Sarin Does it Take?

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

These numbers are the Lethal Doses 50 (LD_{50}) amounts for 1 minute of exposure to Sarin aerosolized liquid. This means that, in a 1-minute 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 ¼ cup of Sarin to kill 50 percent of the people in an auditorium, and the equivalent of a shot

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

glass to kill 50 percent of the people in a 50-100 person conference room.

It is the aerosol that is most often fatal. For example, the Tokyo subway attack used Sarin liquid and the liquid caused very few deaths. Most casualties were from the closed subway environment where the Sarin aerosolized (evaporated) on its own in the confined space of the subway reaching toxic levels.

VISUAL VIII-C-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. But the vapor is a more effective WMD.
- Inhalation hazard is of greatest concern. Nerve and blister agents pose both a skin and inhalation hazard. The inhalation hazard is of greater concern.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

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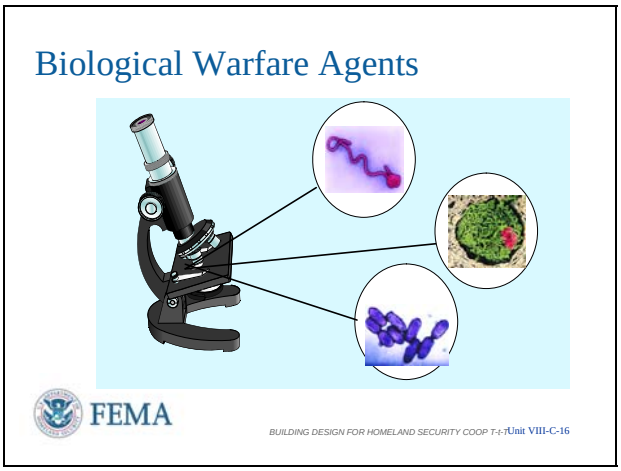

Biological Warfare Agents

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.

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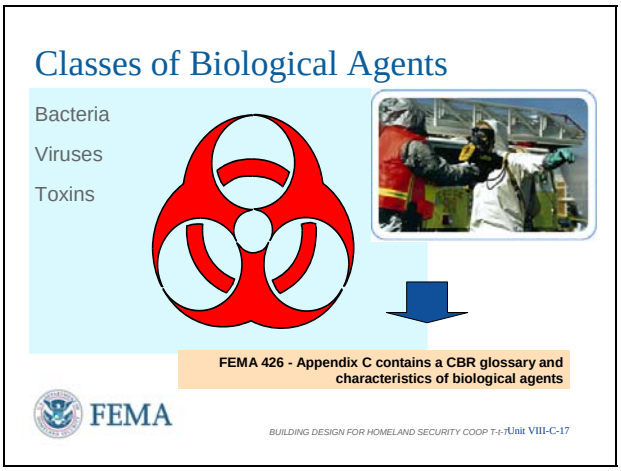

Classes of Biological Agents

- 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 that may poison the body.
- **Toxins** are poisonous substances produced as a byproduct of pathogens or plants and even some animals.

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

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

for biological terrorism.

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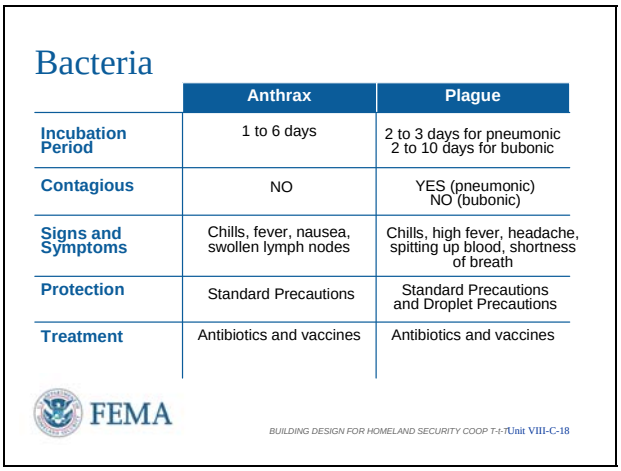


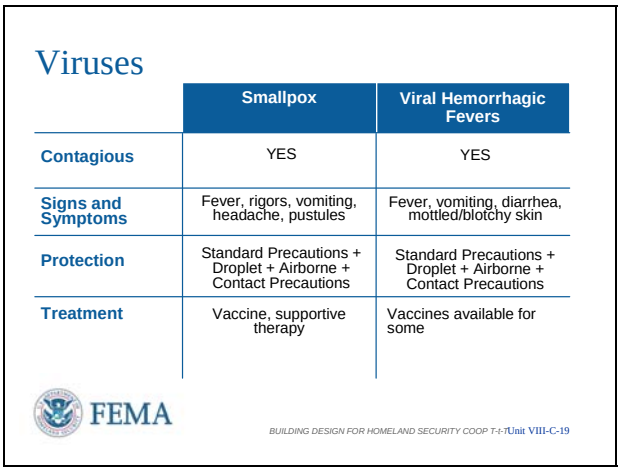
Bacteria

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 or not
- 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 VIII-C-19



Viruses

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

For example, most contagion in smallpox is from people inhaling small droplets from the coughing of infected/contagious persons.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

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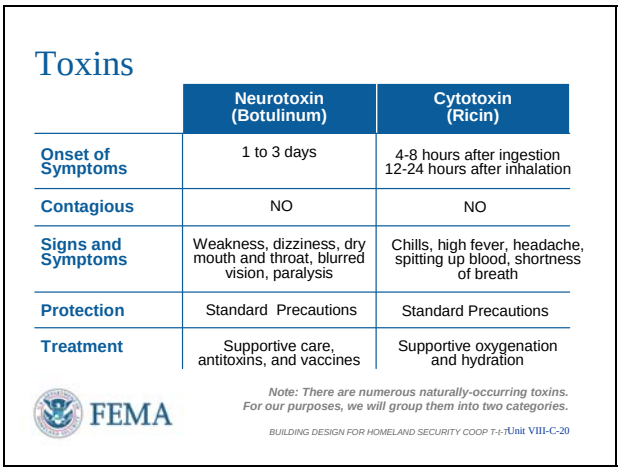


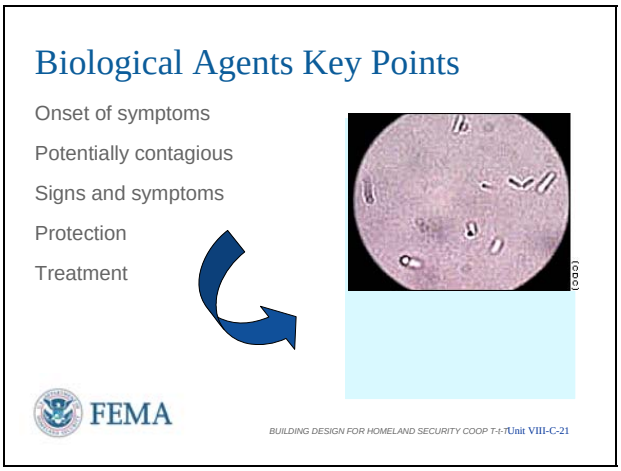
Toxins

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 VIII-C-21



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.

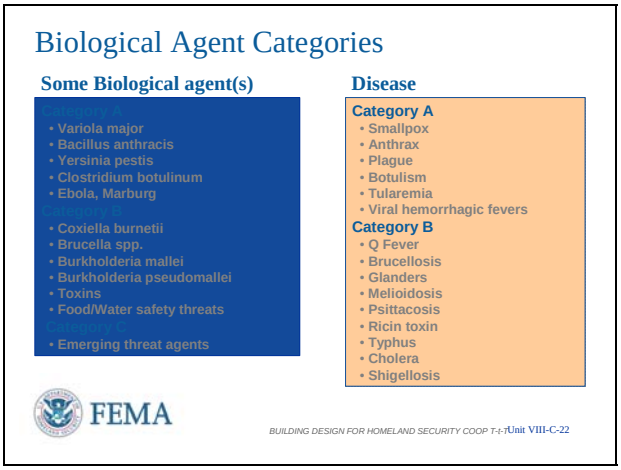
Biological Agents Key Points

NOTE: A very low dose of a biological agent can cause infection and spread disease, thus detection requires high sensitivity, but because there are many biologicals in the environment, detection requires selectivity, and since biological agents are very complex molecules making them difficult to identify/detect.

- **Onset of symptoms:** Most biological agents have an incubation period. Delayed effects will make identifying a biological attack more difficult.
- **Potentially 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.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-22
HIDDEN SLIDE



- **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 none of the aforementioned treatments, supportive care should be administered, such as treating the symptoms.

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.

Biological Agent Categories

Agents are placed in one of three priority categories for initial public health Preparedness efforts based on the overall criteria and weighting of each agent.

Category A: Carry the highest priority because they:

- Can be easily disseminated or spread person-to-person
- Can be highly lethal
- Have the potential for serious public health impact
- Can potentially cause public panic and lead to social disruption

Category B: Carry the second-highest priority because they:

- Are moderately easy to disseminate
- Usually result in moderate morbidity
- Are generally less lethal

Category C: They include emerging pathogens that could potentially be engineered for future mass dissemination.

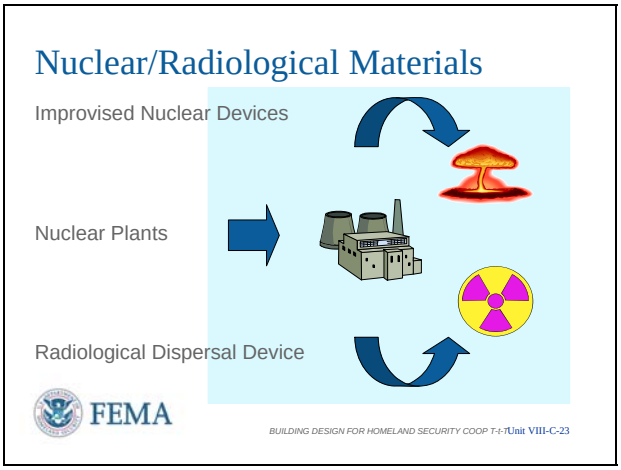
- Nipah virus

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

- Hantavirus

Not believed to present a high bio terrorism risk to the public health today, but could emerge as future threats.

VISUAL VIII-C-23



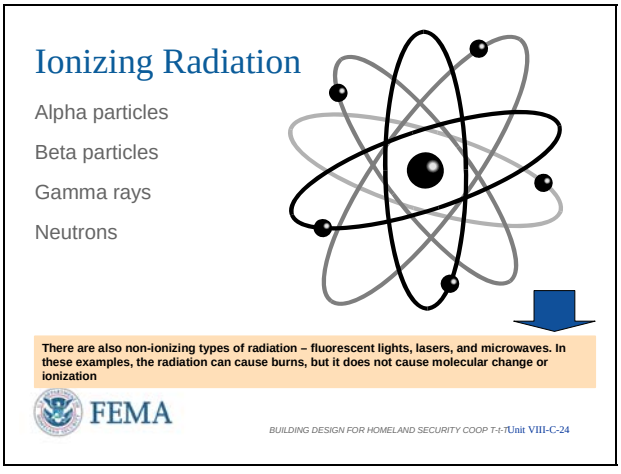
Nuclear/Radiological Materials

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:

- 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 VIII-C-24



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,

Ionizing Radiation

Ionizing radiation is either particle radiation or electromagnetic radiation in which an individual particle/photon carries enough energy to ionize an atom or molecule by completely removing an electron from its orbit. If the individual particles do not carry this amount of energy, it is essentially impossible for even a large flood of particles to cause ionization. These ionizations, if enough occur, can be very destructive to living tissue, and can cause DNA damage and mutations.

For our purposes, ionizing radiation includes:

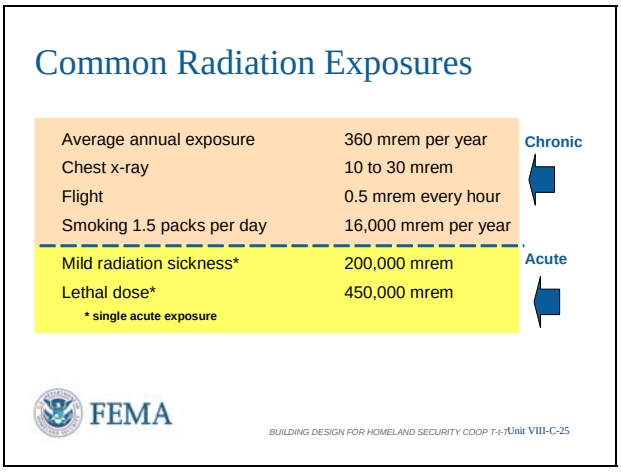
- **Alpha particles**
- **Beta particles**
- **Gamma rays**
- **Neutrons**

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

including humans, can cause some form of reaction.

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

VISUAL VIII-C-25



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.

Dose in rem = RBE x dose in rad
RBE = 1 for gamma radiation and beta radiation above 30,000 electron volts
RBE = 0.7 for photons above 4 million electron volts (minimum found)

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.

Ionizing radiation is what causes injury or death, and is 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*

mrem = millirem
milli- = 10^{-3} or "one thousandth of"
rem = **röntgen** (**roentgen**) **equivalent** in **man** Pronounced "rho – ent – gen" with a long "o" and the two "e" are short
rem is a unit of equivalent dose, much like TNT equivalent for explosives. Rem relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose.
rad is the unit of absorbed dose equal to 100 ergs per gram or 0.01 joule per kg.

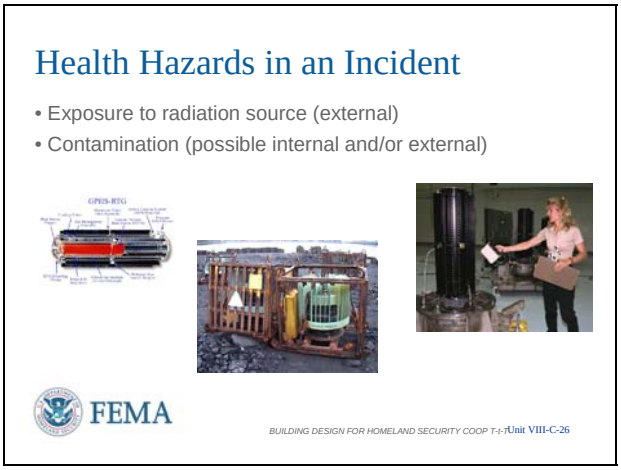
INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

RBE = 20 for heavy ions (maximum found)

(Energy and mass, but not biological damage)

Source of radioactivity in <u>smoking</u> is Lead 210 (beta radiation) and Polonium 210 (alpha radiation) which comes as Radon 222 gas from the soil and is absorbed by the tobacco plant's leaves. While the tobacco plant takes up little radioactivity from the soil directly like it draws other nutrients, it turns out that "developed" countries usually fertilize their tobacco fields with chemically manufactured fertilizer high in phosphate content to make the tobacco more "flavorful" than if nitrogen based fertilizer is used as in poorer countries. The phosphate portion of this fertilizer is made from a rock mineral, apatite, which is ground to powder, dissolved in acid and further processed. Apatite rock contains Radium 226 (the precursor of Radon 222).

VISUAL VIII-C-26



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 internally, or both.

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.

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.

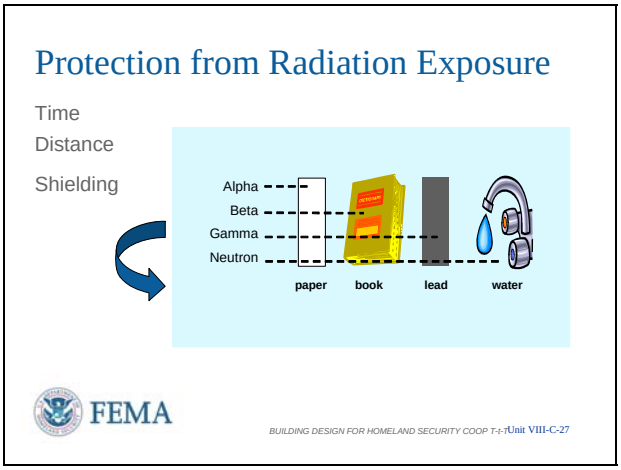
<u>Left Photo</u> - This image shows the cut-away of an actual Radioisotope Thermoelectric Generators (RTG) Unit which produces

<u>Radiological materials are both colorless and odorless.</u>

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

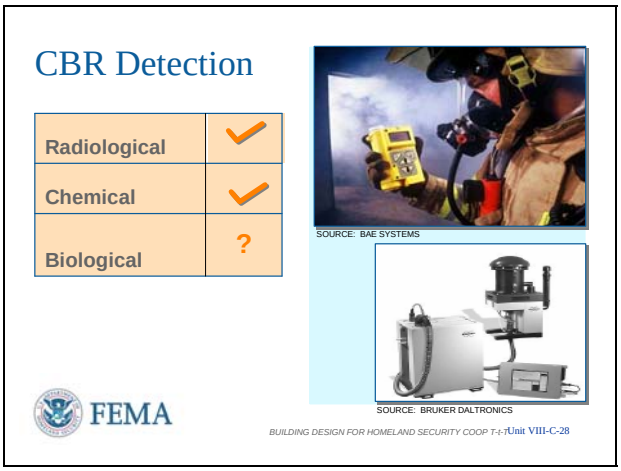
electricity via the thermoelectric effect.
Center Photo - RTG from the Cassini program.
Right Photo - RTG abandoned on the Kola Peninsula, Russia

VISUAL VIII-C-27



Note: Do not shield neutron-producing sources with lead or dense materials as the neutrons react with the material to produce gamma rays. Use wax, water, or plastic instead.

VISUAL VIII-C-28



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 in exposure time.
- **Distance:** Distance is also critical for reducing radiation exposure dose. Although 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 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.

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.

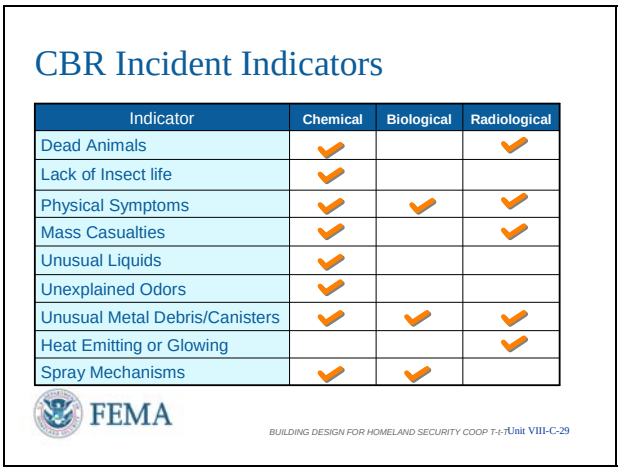
The discussion on **CBR detection** includes:

- CBR detection technology currently available.

INSTRUCTOR NOTES	CONTENT/ACTIVITY
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) (Guide 100-00, Vols 1 & 2), June 2000. • *An Introduction to Biological Agent Detection Equipment for Emergency First Responders*, published by the NIJ (Guide 101-00): December 2001.	• Indications of CBR contamination. • Mass spectrometry. (can positively identify a chemical agent at very low concentrations) • 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. Biological detection requires sensitivity (very low effective dose must be detected), selectivity (there are many biologicals in the environment, thus must discern the contagious/deadly ones), and identification of very complex molecules (the complexity makes them difficult to identify). A variety of **radiological detectors** have been developed for the nuclear industry and are commercially available.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-29



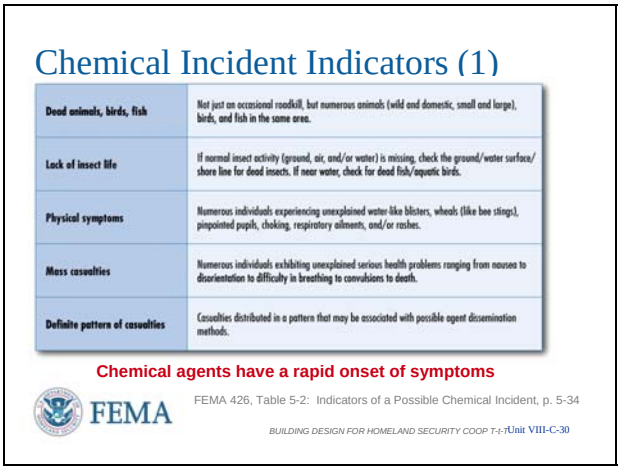
CBR Incident Indicators

This is a summary table indicating warning properties of CBR agents in terms of dead animals, lack of insect life, physical symptoms, mass casualties, unusual liquids, unexplained odors, unusual metal debris, heat emitting or glowing, and spray mechanisms.

Details provided in visuals VIII-C-30, -31, -32, and -33.

In general, chemical agents will typically have a rapid onset of symptoms, while the response to biological or radiological agents can be delayed. Potential indicators of threats include suspicious packages or containers or unusual powders or liquids, droplets, mists, or clouds found near air-intake, in air-ventilation ductwork, and HVAC systems.

VISUAL VIII-C-30
HIDDEN SLIDE



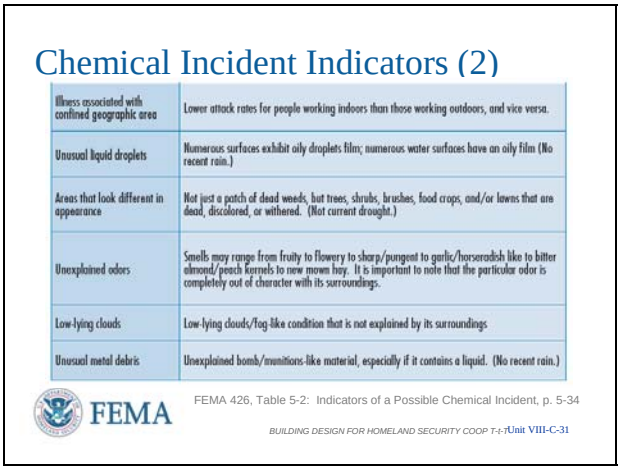
Chemical Incident Indicators (1)

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.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-31
HIDDEN SLIDE

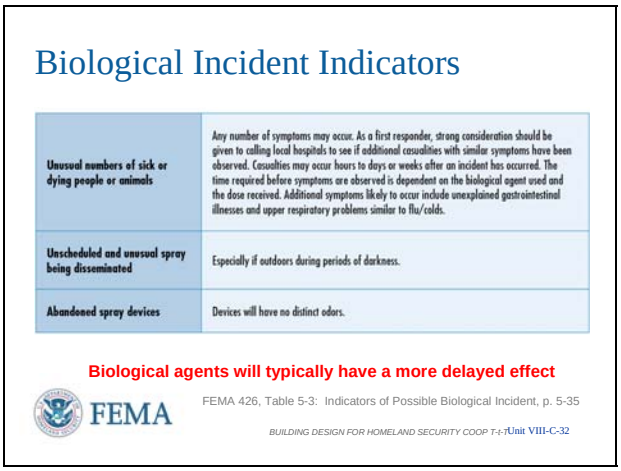


Chemical Incident Indicators (2)

Chart 2 depicts the following chemical indicators:

- Definite pattern of casualties
- Illness associated with a confined geographic area
- Unusual liquid droplets
- Areas that look different in appearance
- Unexplained odors
- Low-flying clouds
- Unusual metal debris

VISUAL VIII-C-32
HIDDEN SLIDE



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.

<u>The indicators of biological attack easiest to identify are unscheduled and unusual spraying and abandoned spray devices.</u>

Let's make a distinction between bioterrorism against people and against animals:

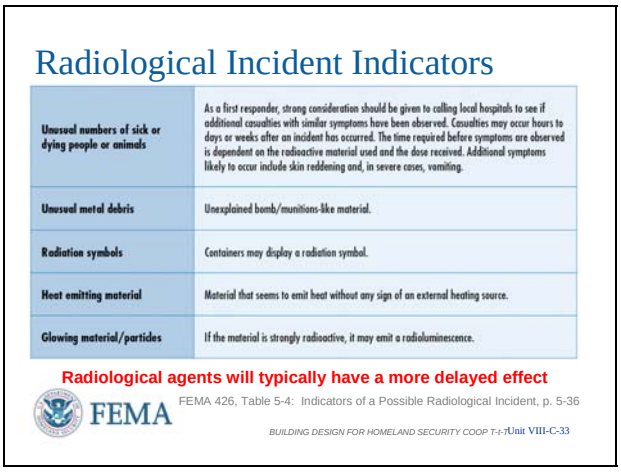
People: Farmers might see cows/livestock get anthrax after an anthrax biological attack (but not cats and dogs). No other commonly discussed biological agents used for people will affect animals. Alternately, rats carry fleas that spread plague, but the rats don't get plague.

Animals: Unlikely to happen and if it does few people are going to see it for what it is. It makes another distinction between biological and chemical

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

indicators. However, if the attack is against animals, then animal effects are indications. For example foot and mouth disease or pseudo rabies or swine flu or bird flu would cause huge animal loses but no human deaths (unless you count the recent bird flu deaths by people handling infected poultry and this in contact). But these latter instances are not bioterrorism yet.

VISUAL VIII-C-33
HIDDEN SLIDE

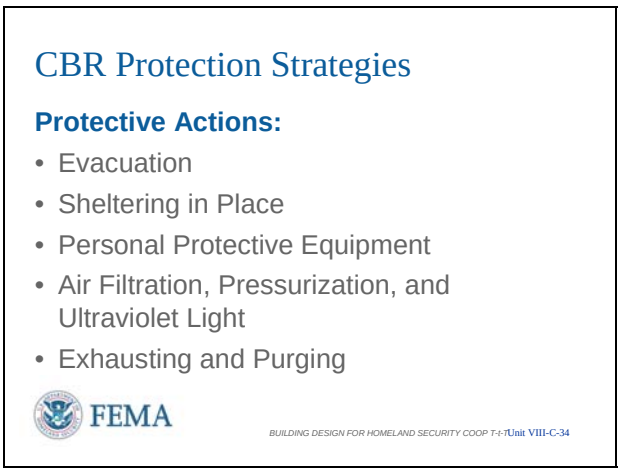


Radiological Incident Indicators

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.

It is fortunate the radiological detectors are so mature to detect radiation sources and residual radiation.

VISUAL VIII-C-34



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

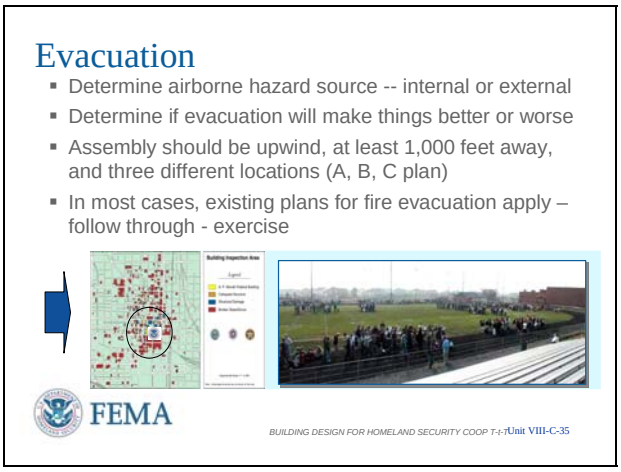
To ensure the protective actions are effective you must have:

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

- 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 VIII-C-35



This map displays 1,000 foot radius to determine minimum evacuation distance, 2,000 feet would be better.

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.
- There must be some detection method or knowledgeable personnel in place to make the determination of what to do – evacuate or some other action. This may be trained first responders, but even their response time can be too long depending upon the situation.
- 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.
- The evacuation plan should list each contingency and the decision process.

VISUAL VIII-C-36

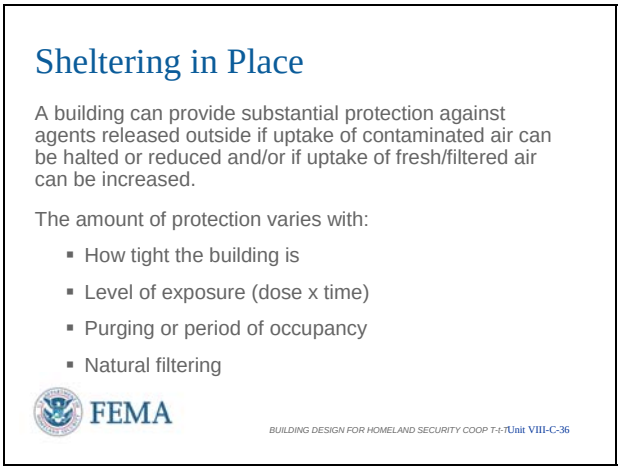
Sheltering in Place

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

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**



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

FEMA 453 covers square footage required per person for various short and long term situations for people of various capabilities.

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.
- Sealing dampers on air intakes
- Previously sealed all identifiable air leakage in building envelope (smoke test or infrared survey on very hot or very cold day)
- This presupposes that all HVAC and other mechanical means that move air, including bathroom exhausts and elevators, are shutdown to not draw outside air into the building

The level of exposure. Protection varies with agent concentration and time, diminishing as the time of exposure increases or as concentration of agent increases. Thus a high-concentration plume passing quickly over a building would indicate sheltering in place to be the best option.

Purging or period of occupancy. How long occupants remain in the building after the hazardous cloud has passed also affects the level of protection. However, after the high-concentration plume passes, there will be some inleakage of agent that does occur and the longer one stays in the building the higher the exposure, unless the building is purged or aired out.

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 VIII-C-37
HIDDEN SLIDE

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 turn off all air handling equipment, isolate stairwells, and not use elevators.

Sheltering in Place

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

- Identifying all air handling units, fans, bathroom exhausts, and the switches needed to deactivate them
- Identifying cracks, seams, and joints in the building shell to be permanently sealed or temporarily sealed, along with sealing doors with duct tape
- Prepositioning supplies that are needed to initiate and sustain sheltering in place
- Identifying safe rooms or safe havens
- Identifying procedures for purging or airing out after an internal release
  - This must be done on a case-by-case basis for the agent involved and the agent concentration to be spread during the purging.
  - Competent first responder authority may best make this determination.
  - Sealing the release area and evacuating the building may be a better option and do not touch those purge fans!
- Identifying procedures for voluntary occupant participation
  - <u>During an event, the decision to shelter in place is voluntary</u>
  - Current law does not require people to use the shelter
  - People should enter the designated shelter area within 3-5 minutes. Depending upon plume speed and distance to travel, even this may be too long.
- Maintaining communications to understand what is occurring by monitoring TV or radio

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-38

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

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.
- Universal hoods designed for short duration escape wear only protect against chemical agents by using both HEPA and carbon filters.
  - Carbon filters are designed to filter a broad range of toxic chemicals, but not all chemicals.
  - The EVAC-U8 hood was recalled in April 2006 due to a problem with removing carbon monoxide, which was a stated claim, applicable to its use as a fire escape hood, but it is NOT a CBR hood.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-39

Shows pictures of aftermath of the tragic 9-11 events.

9-11 Dramatic Events

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.

Starting from top left:

Photo 1 - Remains Recovery

Photo 2 - Evacuation by Helicopter

Photo 3 - Arlington County EMS (Emergency Medical Services) unit

Photo 4 – NMRT (National Medical Response Team) decontamination corridor

Bottom left:

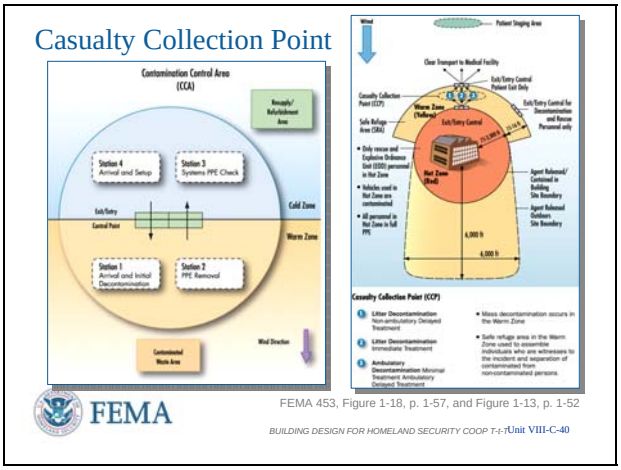
Photo 5 - Evidence Collector

Photo 6 - Man covered in debris from the Twin Towers collapse

Photo 7 - FEMA Urban Search and Rescue (US&R) Team from Montgomery County, MD is briefed before beginning work at Pentagon following 9-11 attacks.

Photo 8 - FBI and US&R

VISUAL VIII-C-40



Casualty Collection Point

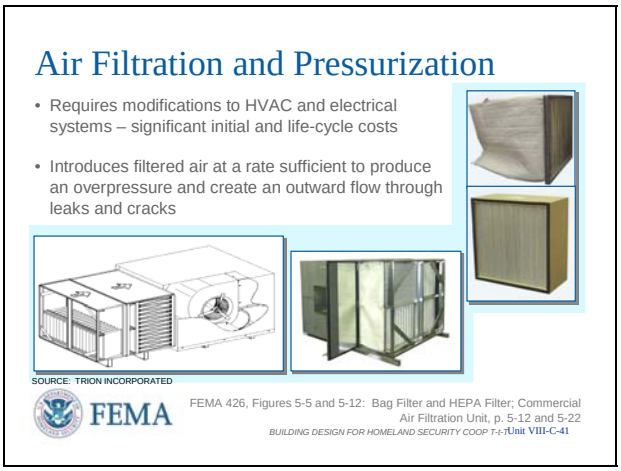
Emergency operations need to be designed to allow law, fire, and medical vehicles and personnel access for mass decontamination operations.

The Contamination Control Area is located on the boundary of the Cold Zone and Warm Zone and used by the rescue and decontamination personnel to enter and exit the Warm Zone. There are several processing stations, a resupply and refurbishment area, and a contaminated waste storage area. Runoff from

INSTRUCTOR NOTES	CONTENT/ACTIVITY
To summarize the right column: During planning, you need to identify the following on your site as part of your OEP (Occupant Emergency Plan): ▪ Areas for victims that require transportation ▪ Areas for rescue and decontamination personnel ▪ Areas for survivors that require decontamination	decontamination operations must be controlled or contained to prevent further site contamination. Casualty Collection Point is a critical element to save lives. The following operations may take place during an emergency operation. • The Patient Staging Area (PSA) is located in the Cold Zone and is the transfer point for victims that have been stabilized for transport to higher care medical facilities or for fatalities to be transported to morgue facilities. The PSA area must be large enough to accommodate helicopter operations and a large number of ambulances. • The Casualty Collection Point is located in the Warm Zone and will have typically have three processing stations: o Station 1 – Litter decontamination and non-ambulatory delayed treatment patients o Station 2 – Litter decontamination and immediate treatment patients o Station 3 – Ambulatory decontamination, minimal treatment patients, and ambulatory delayed treatment patients • Mass casualty decontamination occurs in the Warm Zone. The Safe Refuge Area is located in the Warm Zone and is used to assemble individuals who were witness to the incident and separation of contaminated from non-contaminated persons.

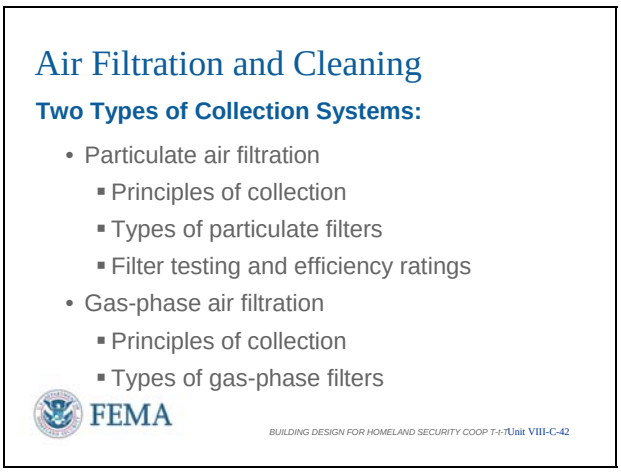
INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-41



Note: Applying external filtration to a building requires modification to the building's heating, ventilation, and 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.

VISUAL VIII-C-42



See CDC/NIOSH *Guidance for Filtration and Air-Cleaning Systems to Protect Building Environments from Airborne Chemical,*

Air 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.

NOTE to instructor: Emphasize to students that from this slide on the information will help the student to understand CBR issues and how to mitigate HVAC Systems when vulnerabilities are noted.

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

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

Biological, or Radiological Attacks. Publication No. 2003-136, April 2003 for good explanations of these two types of filtration.

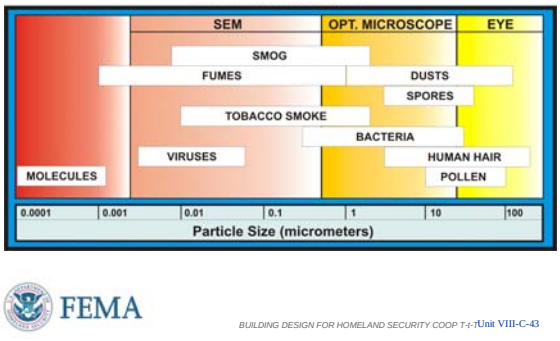
rapidly. Particulate filters are not intended to remove gases and vapors.

Gas-phase air filtration sorbent filters use one of two mechanisms for capturing and controlling gas-phase air contaminants: physical adsorption and chemisorption. 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.

Sorbent filtration needs adequate residence time to ensure adsorption of the gas or vapors; that is adequate contact time for the flow rate of the air passing through the filters. In some cases, two sorbent filters may be needed in series to achieve needed residence time.

Air Contaminant Sizes

VISUAL VIII-C-43

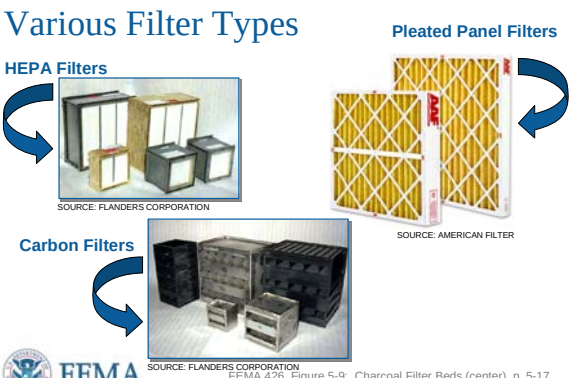


This chart illustrates the particle size for a number of the chemical, biological, and radiological agents of concern. Viruses are the smallest and most difficult to protect against.

In **FEMA 426, Table 5-1, page 5-12,** lists the new ASHRAE 52.2 Standards for particulate filter ratings to remove a given particle size. In most cases, new generation **Minimum Efficiency Reporting Value** (MERV) 11 to MERV 13 [**removal down to 0.3 to 1 micron**] filters can be used in commercial buildings and **effectively remove most particulates of CBR concern**.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-44



FEMA 426, Figure 5-9: Charcoal Filter Beds (center), p. 5-17

BUILDING DESIGN FOR HOMELAND SECURITY COOP T-t-T Unit VIII-C-44

Various Filter Types

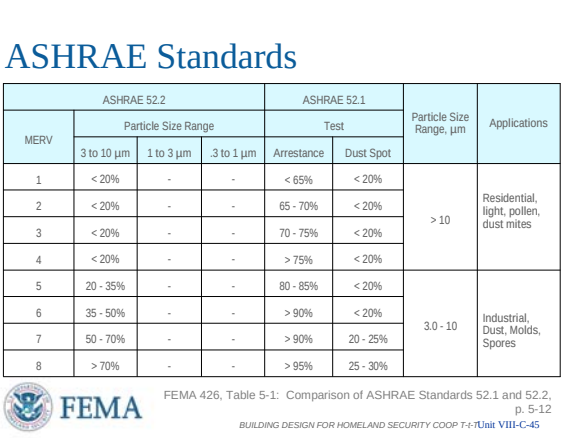
A wide variety of filters are available to meet many specialized needs:

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.

VISUAL VIII-C-45



ASHRAE 52.2				ASHRAE 52.1		Particle Size Range, µm	Applications
MERV	Particle Size Range			Test			
	3 to 10 µm	1 to 3 µm	.3 to 1 µm	Arrestance	Dust Spot		
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%		

FEMA 426, Table 5-1: Comparison of ASHRAE Standards 52.1 and 52.2, p. 5-12

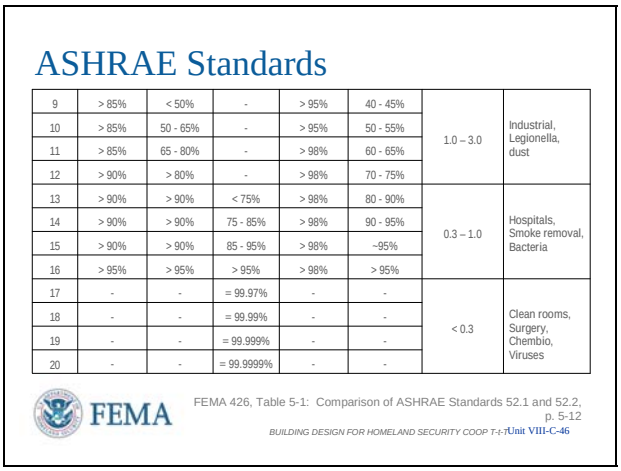
BUILDING DESIGN FOR HOMELAND SECURITY COOP T-t-T Unit VIII-C-45

ASHRAE Standards

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 MERV rating between 1 and 20. A higher MERV rating indicates a more efficient filter.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

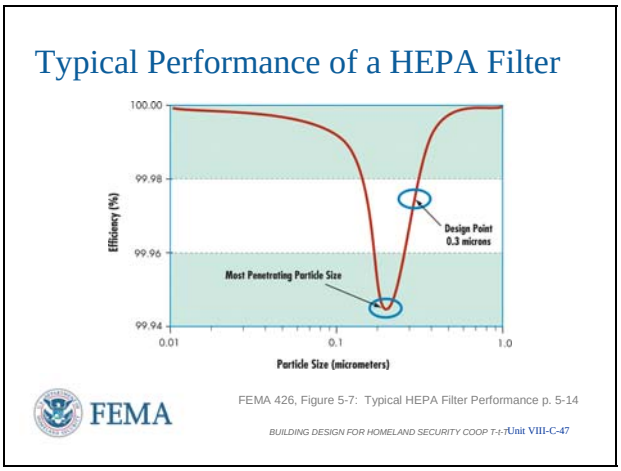
VISUAL VIII-C-46



ASHRAE Standards

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 VIII-C-47
HIDDEN SLIDE



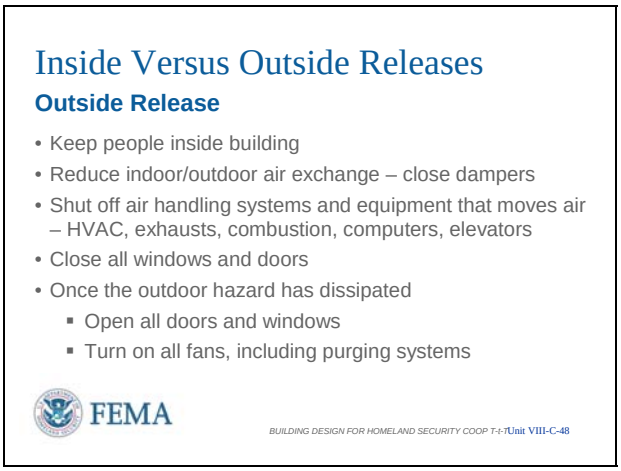
Typical Performance of a HEPA Filter

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 micron 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 facilities couple particulate air filters with ultraviolet germicidal irradiation (UVGI). UVGI will be discussed on slide VIII-C-55.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-48



Outside Versus Inside Releases

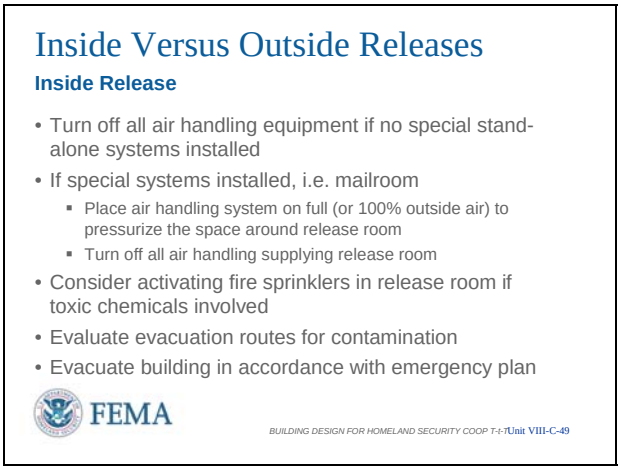
Outside Release

The intent is to limit exposure (dose x time) of individuals by keeping the agent and people separated to greatest extent possible. Use natural wind, sunlight, and agent material properties to allow the high-concentration plume to pass the building and minimize the agent that gets into the building.

- Keep individuals inside the building – use the building envelope as a protective enclosure
- Reduce the indoor/outdoor air exchange (seal dampers – low leakage, fast acting (much less than 30 seconds to close) dampers) to prevent contaminated air from passing through the HVAC system by normal chimney and wind effects
- Immediately shut off the air handling systems and any other system that has a fan that moves air – bathroom exhausts, combustion burners, computer cabinet cooling fans, etc. Note that elevator operation acts as a big air pump that changes air pressure throughout the building. Do not want to set up a pressure differential that pulls outside air into the building when this outside air is contaminated.
- Close all windows and doors – Should have sealed all other leakage points throughout the building envelope as part of mitigation plan
- Once the outdoor hazard has dissipated, open all doors and windows and turn on all fans to ventilate the building. While the amount of agent entering the building should be low (low dose) if you do not ventilate the building the exposure time

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-49



becomes great and the overall level of exposure can become dangerous.

Outside Versus Inside Releases

Inside Release

The intent here is to keep the release contained to the greatest extent possible and prevent it from getting to the other parts of the building or outside the building.

- This process must be well thought out, coordinated, and tested to ensure the building will function as desired.
- If the building cannot be operated this way, then follow outside release procedures, but with evacuation.

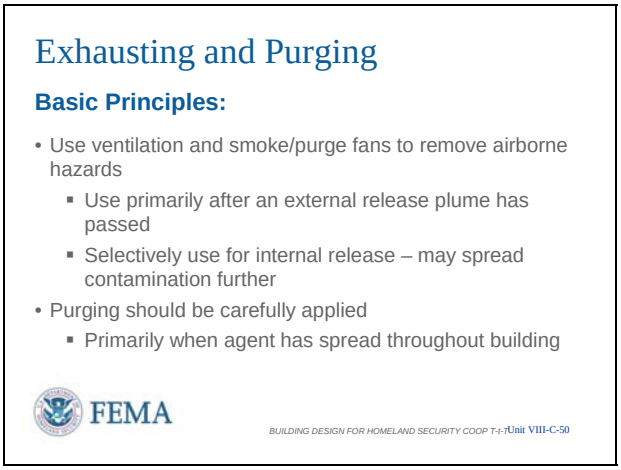
- If no special stand-alone systems, then shut down all air movement equipment
- If release is in a room with a special stand-alone system, then shut down that system and place the rest of the building's air handling system on "full (or 100%) outside air to keep the agent inside the release room.
- If advised of an in-building release of hydrogen cyanide gas, chlorine gases, or other toxic industrial chemicals, consider activating the fire sprinklers (water) to help wash the contaminant from the air stream. This would probably help for particulate aerosols like anthrax but will probably not work for vapors such as hydrogen cyanide gas or chlorine gas.
  - The negative to this process is that the water is now contaminated and can spread throughout the building.
  - The runoff water will also contaminate building components to a greater extent that if the sprinklers were not used, necessitating a greater clean-up effort.
  - Note that this type of operation is not

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

standard on fire sprinkler systems and would be very difficult to implement.

- Evacuate the building in accordance with the building's emergency evacuation plan. Evacuation routes may be hazardous because they may take people through contaminated areas. It is necessary to evaluate the scenario prior to evacuating the building to prevent additional injuries from occurring.

VISUAL VIII-C-50



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.

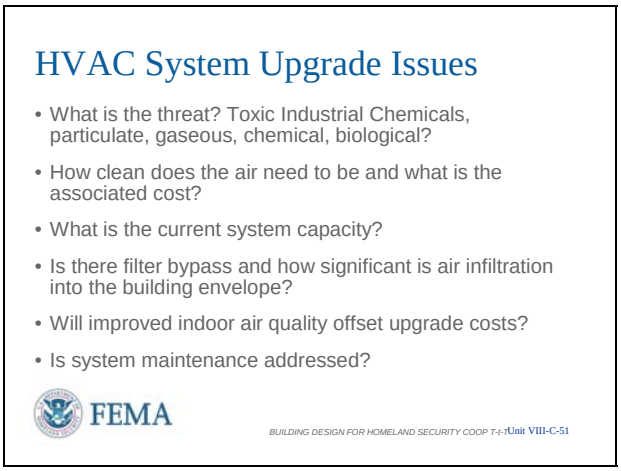
Exhausting and Purging

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.

- Purging must be carefully applied with regard to the location of the source and the time of the release. The main action is final clean-out of the building to allow a return to occupancy.
- 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, the adjacent area, and to nearby buildings. In this case, all air handling units should be turned off to isolate the hazard while evacuating or temporarily sheltering in place.
- When purging, the indoor-outdoor air exchange rate can be increased by opening all windows and energizing all other fans.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

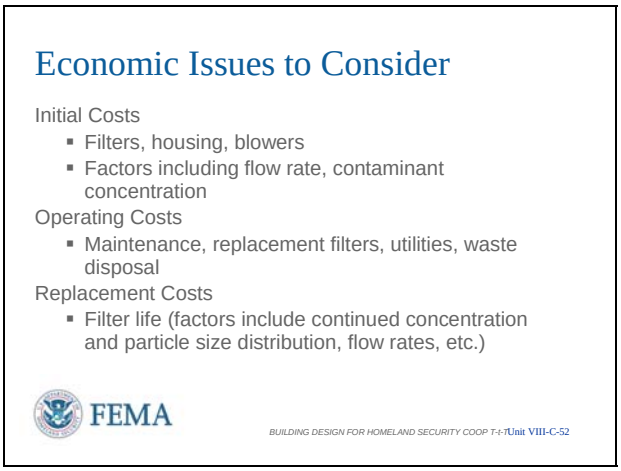
VISUAL VIII-C-51



HVAC System Upgrade Issues

- What is the threat?
- How clean does the air need to be and what is the associated cost?
- What is the current system capacity? [Cubic feet per minute (CFM) and pressure drop allowed across existing filters. Will upgraded filters result still achieving CFM required?]
- Is there filter bypass and how significant is air filtration into the building envelope?
- Will improved indoor air quality offset upgrade costs?
- Is system maintenance addressed?

VISUAL VIII-C-52



Economic Issues to Consider

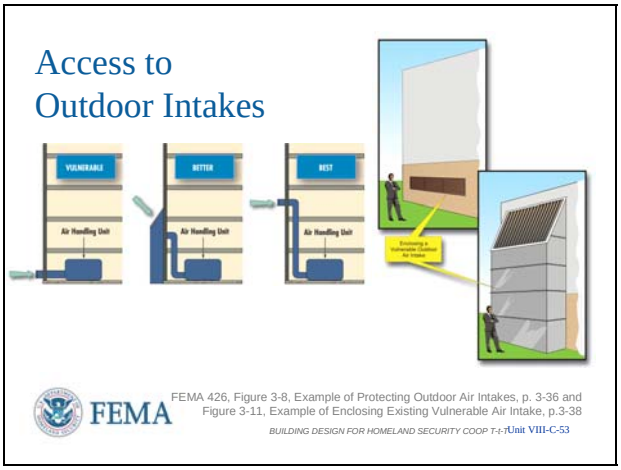
In developing, implementing, and sustaining a program to reduce vulnerability to terrorist threats, there are economic issues to consider, including three categories of costs:

- Initial costs
- Operating costs
- Replacement costs

These need to be factored into protection strategies.

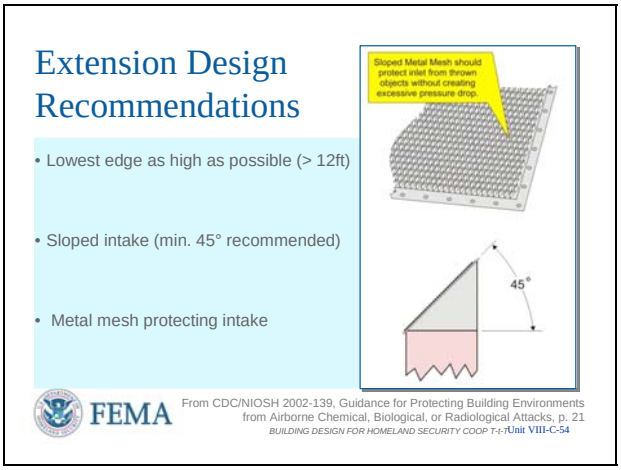
INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-53



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

VISUAL VIII-C-54
HIDDEN SLIDE



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.

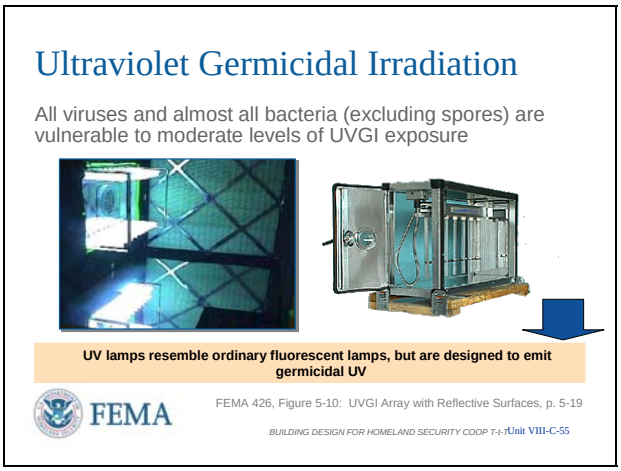
This is a good idea for other reasons, such as keeping grass clippings, lawnmower fumes, and/or traffic fumes from being pulled into the building because of a low intake.

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.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-55



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 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.

A UVGI system is being tested under the sponsorship of the Defense Advanced Research Projects Agency (DARPA). For additional information consult: http://www.novatroninc.com/technology/.

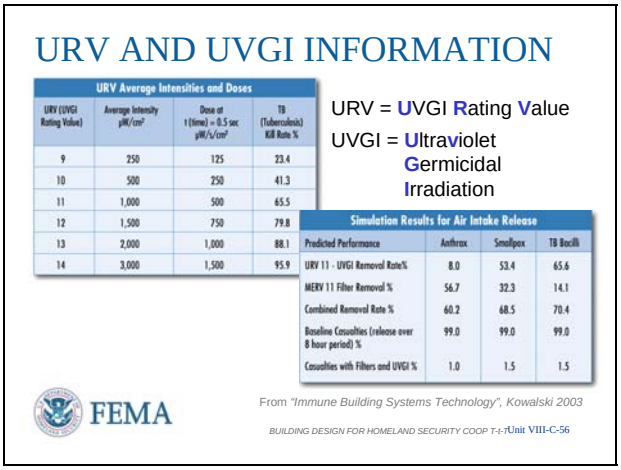
Ultraviolet Germicidal Irradiation (UVGI)

A design utilizing a combination of filtration and UVGI can be very effective against biological agents.

- Smaller microbes are difficult to filter out, but tend to be more susceptible to UVGI
- Larger microbes, such as spores, which are more resistant to UVGI, tend to be easier to filter out.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-56
HIDDEN SLIDE

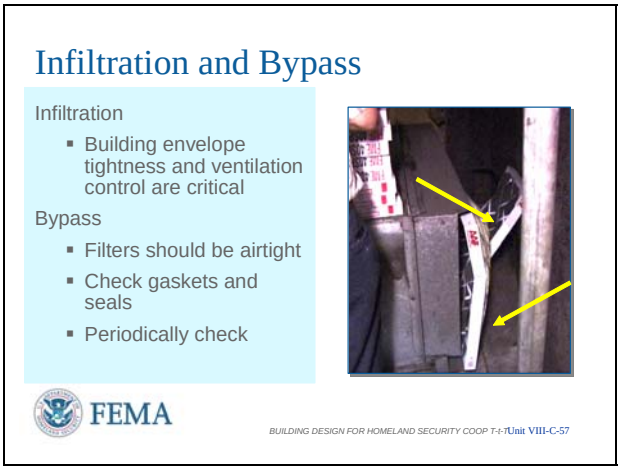


URV and UVGI Information

This table displays UVGI Rating Value (URV) for air disinfections systems that parallel the ASHRAE 52.2-1999 method for testing and rating filters known as MERV (minimum efficiency reporting value). The proposed URV rating system consists of 20 separate levels of average UVGI intensity.

Simulation Results for Air Intake Release Various simulations were run in the reference shown indicating the removal rates for three design basis pathogens for MERV 11 filters, URV 11 UVGI systems, and both working together. Note the almost 100 % casualties if the agent is released into the air intake over an 8-hour period without any protective systems installed, and that about 1 % casualties occur with MERV 11 and URV 11 systems working together for the same release.

VISUAL VIII-C-57



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 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.

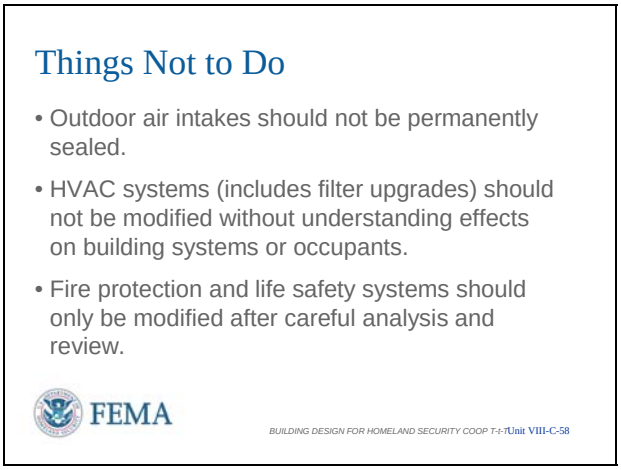
Bypass. Filter bypass is a common problem found in many HVAC filtration systems. It occurs when air, rather than moving through the filter, goes around it, decreasing collection efficiency and defeating the intended purpose of the filtration system.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

infiltration, as much air may enter a building through infiltration as through the mechanical ventilation system.

NOTE to instructor: Emphasize to students that this slide is a good example of what looks like just poor maintenance actually creates a critical system flaw that will affect HVAC system performance in handling CBR situations. A filter is only good if ALL the air flows through it.

VISUAL VIII-C-58



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.

Things Not to Do

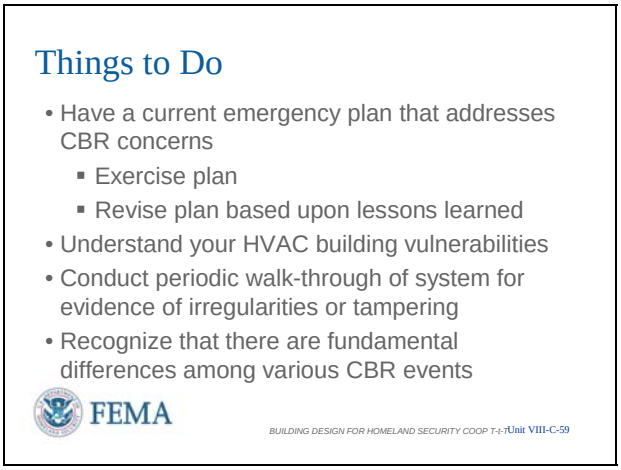
More than anything else, building owners and managers should ensure that any actions they take do not have a detrimental effect on the building systems (HVAC, fire protection, life safety, etc.) or the building occupants under normal building operation.

Some efforts to protect the building from a CBR attack could have adverse effects on the building's indoor environmental quality. This can result in higher levels of illness among building occupants, much like “sick” building situations or long distance air travel.

Building owners and managers should understand how the building systems operate and assess the impact of security measures on those systems.

INSTRUCTOR NOTES | **CONTENT/ACTIVITY**

VISUAL VIII-C-59

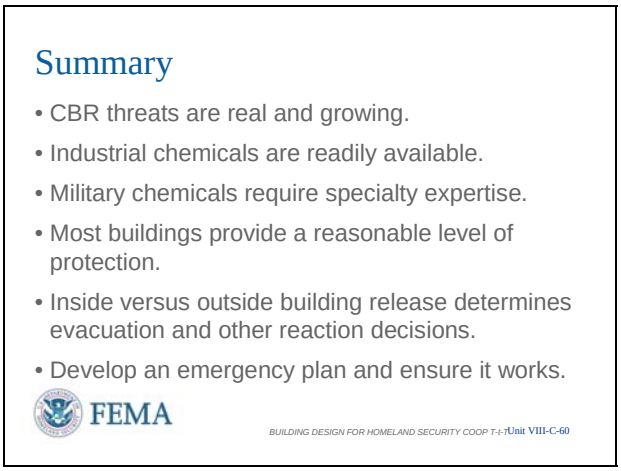


Things to Do

Facilities managers should have a current emergency plan that addresses chemical, biological, and radiological (CBR) attacks, know their building HVAC system vulnerabilities, and conduct periodic walk-through inspections of the systems for evidence of irregularities or tampering.

Individuals developing emergency plans and procedures should recognize that there are fundamental differences among various CBR agents.

VISUAL VIII-C-60



Summary

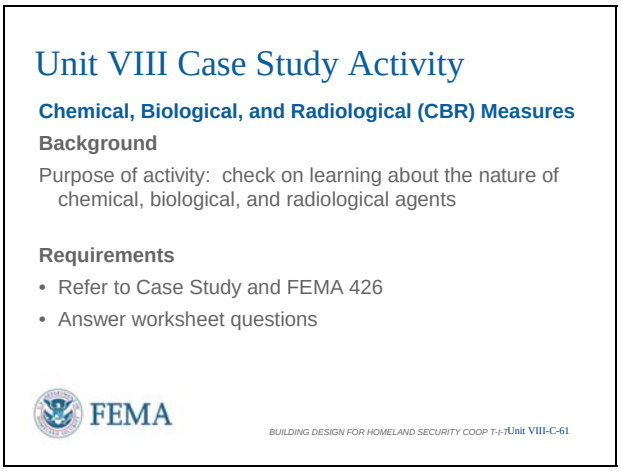
- CBR threats are real and growing.
- Industrial chemicals are readily available.
- Military chemicals require specialty expertise.
- Most buildings provide a reasonable level of protection.
- Inside versus outside building release determines evacuation decision.

Bottomline: Develop an emergency plan for CBR attacks, knowing what actions will be taken, exercise the capability and ensure it works.

At worst, a thorough CBR analysis of HVAC systems will result in good recommendations for energy conservation and proper system maintenance.

INSTRUCTOR NOTES

VISUAL VIII-C-61



Refer participants to **FEMA 426** and the Unit VIII 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.

CONTENT/ACTIVITY

Student Activity

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

Activity Requirements

Working in your small groups, refer to the CI/BC Case Study and **FEMA 426** to answer the worksheet questions.

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

Transition

This completes the background information in Units I through VIII. The next three units will cover vulnerabilities and mitigation measures.

Unit IX will cover Site and Layout Design Guidance.

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UNIT VIII (C) CASE STUDY ACTIVITY: CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) MEASURES (COOP Version)

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

Requirements

1. Identify the prevalent CBR threat(s) that exist and/or are identified as the Design Basis Threat in the Case Study.

Appendix C: Cooperville Information / Business Center

Design Basis Threat

Chemical: ***Large quantity gasoline spill and toxic plume from the adjacent tank farm, small quantity (tanker truck and rail car size) spills of HazMat materials (chlorine).***

Biological: ***Anthrax delivered by mail or in packages, smallpox distributed by spray mechanism mounted on truck or aircraft around metropolitan area.***

Radiological: ***Small "dirty" bomb detonation within the 10-mile radius of the CI/BC building.***

Other:

Chemical: 1) There are a significant number of hazardous waste sites in near proximity to the CI/BC building. The vast majority are small generators such as gas stations, dry cleaning, and other commercial businesses.

2) CI/BC is surrounded by a number of commercial activities and key national critical infrastructure to include Hazardous Material (HazMat) facilities, HazMat being transported on the roads and rails, a nearby fuel tank farm, and an airport.

3) There are two large manufacturing plants with large quantities of hazardous materials stored on site within 2 miles of the CI/BC 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)

4) Approximately 5,000 trucks per day pass the CI/BC office on the nearby interstate highway. About 30 percent of these trucks (1,500 trucks/day) carry placards indicating that HazMat is aboard, but only about 5 percent (250 trucks/day) carry sufficient HazMat to warrant placarding.

5) Approximately 50 percent of the HazMat passing the CI/BC office is Class 3 (flammable and combustible liquids). Class 2 (gases) and

Class 8 (corrosives) each constitute about 15 percent. Approximately 10 percent of the trucks carry more than one class of HazMat.

6) ***It is estimated that approximately 10,000 railcars of HazMat move through this area each year. Hazardous materials range from liquid petroleum products to chlorine to anhydrous ammonia.***
7) ***A leg of the Piedmont Petroleum Pipeline (PPP) runs underneath the office park in the vicinity of CI/BC 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.***
8) ***Connected to the pipeline, less than 1 mile from CI/BC, is a 20-million gallon capacity fuel farm. Operated by the Shellexxico Company, this tank farm stores a variety of petroleum products, primarily gasoline. Thirteen tank trucks were observed leaving the tank farm in a 1- hour period, indicating a calculated movement rate of approximately 300 trucks per day (about 3 million gallons of fuel).***

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 80 percent of Legionella and dust particulates (1 to 3 microns)? ***12***

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

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