Chemical Agents

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Lesson Administrative Page

Module: Chemical Agents

Scope: This module provides students with an understanding of chemical agents and Toxic Industrial Chemicals (TIC) used as Weapons of Mass Destruction (WMD).

Instruction Objective(s):

Terminal Learning Objective: At the conclusion of this module, individuals will describe selected chemical agents and TIC terms, definitions, characteristics, and recognize the physiological signs and symptoms of exposure.

Enabling Learning Objective 1.1: Describe toxic industrial chemicals used as weapons and the physiological signs/symptoms associated with them

Enabling Learning Objective 1.2: Describe choking agents and the physiological signs/symptoms associated with them

Enabling Learning Objective 1.3: Describe blood agents and the physiological signs/symptoms associated with them

Enabling Learning Objective 1.4: Describe blister agents and the physiological signs/symptoms associated with them

Enabling Learning Objective 1.5: Describe nerve agents and the physiological signs/symptoms associated with them

Practical Exercise: None

References:

- Center for Domestic Preparedness, Office for Domestic Preparedness. *Technical Emergency Response Training (TERT).* Anniston, AL: CDP, 2004.
- "Safety and Health Topics: NIOSH/ OSHA/ DOE Health Guidelines." U.S. Department of Labor. 20 Aug. 2004. ‹http://www.osha.gov/SLTC/healthguidelines/index.html›.
- "NIDA InfoFacts." National Institute on Drug Abuse. 20 Aug. 2004. ‹http://www.nida.nih.gov/Infofaxindex.html›.
- U.S. Department of Transportation. *2000 Emergency Response Guidebook.* Chicago: LabelMaster, 2000.

- Sidell, Frederick R., et al. *Jane's NBC Chem-Bio Handbook.* 2nd ed. Surrey, UK: Jane's Information Group, 2002.

- "The Science of Smell Part 1: Odor Perception and Physiological Response." May 2004. Iowa State University. 19 Aug. 2004. ‹http://www.extension.iastate.edu/publications/pm1963a.pdf ›.

- "The Lessons of Halabja Warning. An Ominous Warning." International Information Programs. 19 Aug 2004. ‹http://usinfo.state.gov/products/pubs/iraq/warning.htm›.

- Instant Access to the Minds of Medicine. "Excerpt from CBRNE-Incapacitating Agents, 3- Quinuclidinyl Benzilate." 19 Aug. 2004. ‹http://www.emedicine.com/emerg/byname/cbrne---incapacitating-agents-3-quinuclidinyl-benzilate.htm›.

Duration: 1.0 hours (When this course is taught as Train the Trainer, the duration is extended to 2.0 hours in order to provide time to discuss teaching points thoroughly.)

Method of Instruction: Facilitated seminar format in a classroom environment

Instructor Ratio: 1:50 Students

Required Reading Assignment(s): None

Evaluation Strategy: End of class discussion

Chemical Agents

Describe toxic industrial chemicals used as weapons and the physiological signs/symptoms associated with them

Describe choking agents and the physiological signs/symptoms associated with them

Describe blood agents and the physiological signs/symptoms associated with them

Describe blister agents and the physiological signs/symptoms associated with them

Describe nerve agents and the physiological signs/symptoms associated with them

Homeland Security

RAIN

Recognize characteristics of chemical agents

Avoid, by protection, the hazards of chemical agents

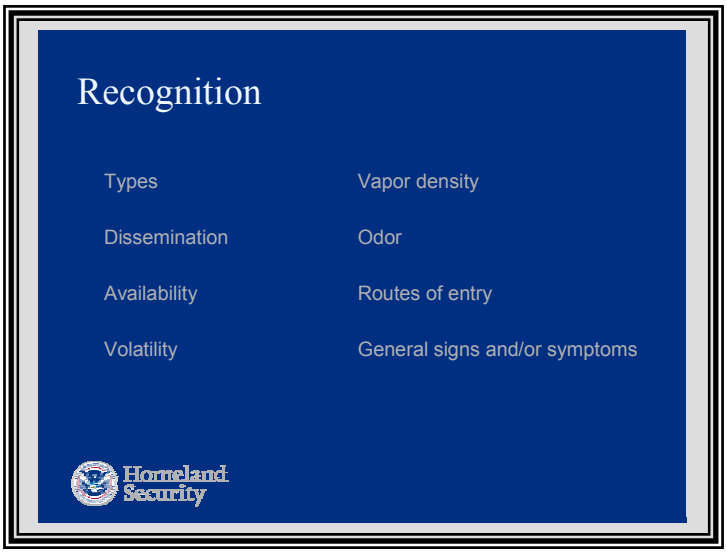
Isolate the hazards of chemical agents

Notify the appropriate resources and authorities when responding to a WMD event possibly involving chemical agents

Homeland Security

Recognize: Chemical Agents as WMD

Chemical incidents are characterized by the rapid onset of medical symptoms (minutes to hours) and easily observed signatures (colored residue, dead foliage, pungent odor, and dead insect and animal life).



- Types—Examples of chemical agents—Including the chemical classification and individual chemicals referencing the *ERG* (*Emergency Response Guidebook*); the U.S. military uses two alphabetical letters to identify chemical agents, such as GB (sarin), VX, etc.; chemical name, trade name/synonym, or military classifications are used interchangeably

- Dissemination—How the agent is dispersed; an especially important consideration for the awareness individual to assist in recognition information, how to evacuate, how to identify agents, etc

- Availability—If the agent is commercially available to acquire, including some examples of how the agent is used in a commercial or household setting

- Volatility—The rate at which a substance evaporates. This is an important factor that determines the extent of the dispersal of a chemical agent. The more volatile a substance, the easier it is to spread. Each substance will be noted as being persistent or non-persistent. Persistent agents, either in a solid or liquid form, pose a contact or inhalational threat by being slow to vaporize. Non-persistent agents rapidly disperse after release and only pose immediate, short-duration hazards (e.g., hours)

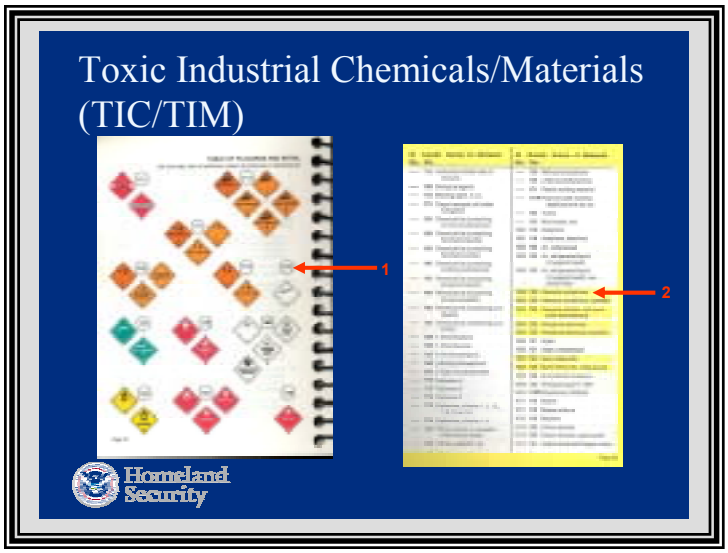
- Vapor density—The mass per unit of volume of a substance under specified or standard conditions of temperature or pressure. This means it is the measure of a gas's density in relationship to air. Air has a vapor density of one. If a vapor is heavier than air, it has a vapor density of greater than one, and if it is lighter than air, it has a vapor density of less than one

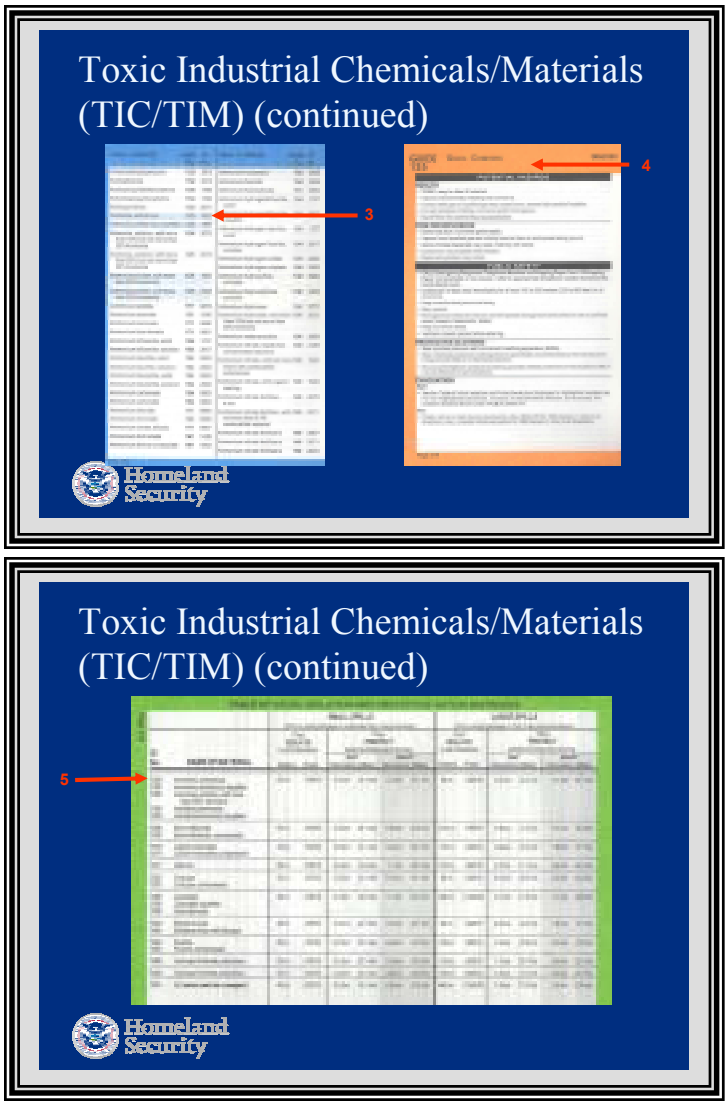
- Odor—Specific smells for each agent. Some chemical agents are accompanied by a characteristic odor that may provide a warning. However, after a while, people may become used to the chemical and no longer detect the smell. The chemical may still be present even if there is no detectable odor. It is important to note that the particular odor is completely out of character with its surroundings. If a particular odor is detected, the area should be evacuated immediately to avoid a potentially dangerous situation. A potentially contaminated environment should not be entered to smell for an indicator

- Routes of entry—Chemical agents have several routes of entry into the body, and they are: inhalation, ingestion, absorption, and injection. This means gases or aerosols can be breathed in. Residue that has settled on food or drink products can be eaten. The agent coming into contact with the skin or mucous membranes (nose, mouth, eyes, open sores, or wounds) can be absorbed into the body

- General signs and/or symptoms—A sign indicates the presence of a disease; a symptom is a change from normal function, sensation, or appearance, generally indicating disease or disorder

Toxic Industrial Chemicals/Materials (TIC/TIM)





1. *ERG*—Numbered placard for anhydrous ammonia listed by three digit Guide Number
2. *ERG*—Anhydrous ammonia information listed in numerical order of ID Number
3. *ERG*—Anhydrous ammonia information listed in alphabetical order by material name
4. *ERG*—Safety and emergency response recommendations according to Guide Number
5. *ERG*—Initial isolation and protective action distances according to material

Though much is presented through the press concerning the super-toxic warfare chemicals, it is very likely that a terrorist may choose to use a more readily available source for a WMD—toxic industrial chemicals used to cause significant casualties. Three examples of potential TICs are provided below that are readily available in communities; other TICs may also be used. Detailed information on these and other potential TICs can be found in the *ERG* and other resource materials.

Anhydrous Ammonia (non-household)

- Type—Anhydrous (ăn-**hī**-drəs) ammonia (ə-**mōn**-yə) (non-household); Guide Number 125; ID Number 1005
- Dissemination—Liquid or gas
- Availability—Commercially available; used for household cleaning, plant growth, making of fertilizer, and metal treatment operations
- Volatility—Non-persistent, meaning it rapidly disperses after its release and only poses immediate, short-duration hazards (e.g., hours)
- Vapor density—Lighter than air depending upon dispersal method. Most of the volume occupied by gas is empty space. This accounts for the lower density of gases compared to liquids or solids. Gas particles tend to travel at high speeds in random directions
- Odor—Very sharp, irritating, pungent odor, similar to cat urine
- Routes of entry—Inhalation, ingestion, or absorption
- General signs and/or symptoms—Severe burns, coughing, nose and throat irritation, blindness, lung damage, and death. Onset of signs/symptoms usually occurs within four hours

Chlorine

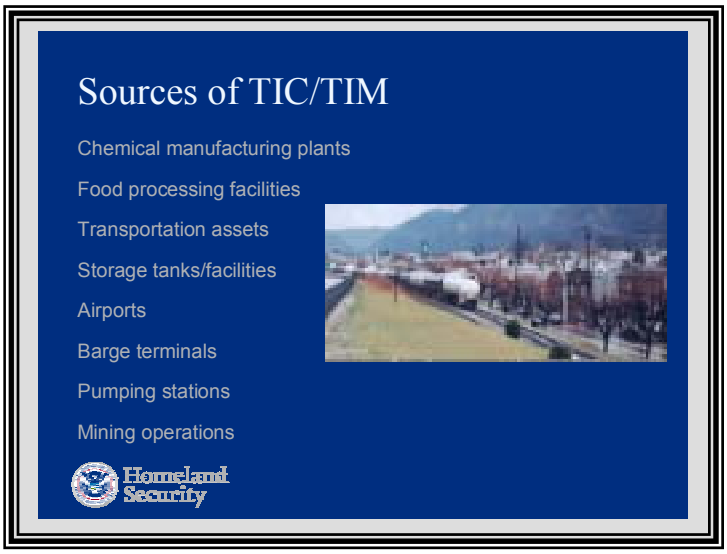
- Type—Chlorine (**klōr**-ēn); Guide Number 124; ID Number 1017
- Dissemination—Liquid or gas
- Availability—Commercially available; used in plastic, solvents, and pesticides, and as a disinfectant in water treatment
- Volatility—Non-persistent, meaning it rapidly disperses after its release and only poses immediate, short-duration hazards (e.g., hours)
- Vapor density—Vapor is heavier than air; liquid is slightly soluble in water
- Odor—Strong, offensive bleach smell
- Routes of entry—Inhalation, ingestion, or absorption
- General signs and/or symptoms—Burns or blisters on the skin from liquid exposure; burning of the eyes, difficulty breathing, nausea and dizziness, congestion and coughing from vapor exposure; tissue swelling from ingestion. Onset of symptoms usually occurs within minutes of exposure

Hydrogen Cyanide

- Type—Hydrogen (**hī**-drə-jən) cyanide (**sī**-ə-nīd); Guide Number 117; ID Number 3294
- Dissemination—Liquid or gas
- Availability—Commercially available; used in fumigation to eliminate rodents and/or insects and as a precursor for the production of cyanide salts
- Volatility—Non-persistent, meaning it rapidly disperses after its release and only poses immediate, short-duration hazards (e.g., hours)
- Vapor density—Vapor is lighter than air; liquid is soluble in water
- Odor—Bitter almond scent
- Routes of entry—Inhalation, ingestion, or absorption
- General signs and/or symptoms—Low to medium exposure—reddening of the skin, headaches, weakness, changes in taste and smell, irritation of the throat, vomiting, effort dyspnea (dĭsp-**nē**-ə), lacrymation (lăk-rə-**mā**-shən), abdominal pain, and nervous instability; high exposure—rapid death. Onset of symptoms will usually occur within seconds depending upon dosage received

Sources of Toxic Industrial Chemicals/Toxic Industrial Materials

Toxic Industrial Chemicals and Toxic Industrial Materials are chemical agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.



- TIC/TIM sources include:
  - chemical manufacturing plants
  - food processing, storage facilities with large anhydrous ammonia tanks, and chemical transportation assets
  - gasoline and jet fuel storage tanks at distribution centers
  - airports, and barge terminals with compressed gasses in tanks, pipelines, and pumping stations
  - industries in which cyanide and mercury compounds are used
  - pesticide manufacturing and supply distributors
  - educational, medical, and research laboratories

Incapacitating Agents

An incapacitating agent (also called irritants, lachrymators, and tear gas) is an agent that produces physiological or mental effects, or both, that may persist for hours or days after exposure, rendering an individual powerless.

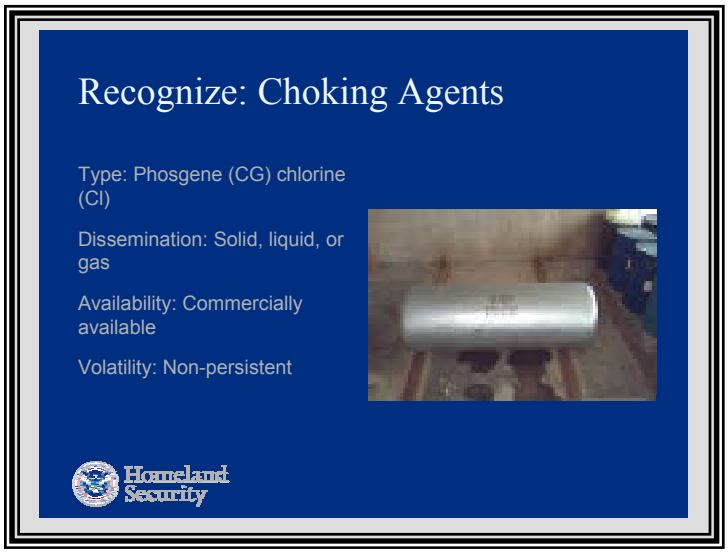
Incapacitating agents such as 3-Quinuclidinyl Benzilate (QNB) have been used by terrorists in the past. In January 1992, soldiers in Mozambique experienced an explosion above their troop formation. Subsequent symptoms resembled those expected from QNB. In July 1995, approximately 15,000 people attempted to walk from the enclave of Srebrenica to the free territory in Bosnia. Many experienced hallucinations during their march that were suspected to be secondary to QNB.

Chemical Warfare Agents

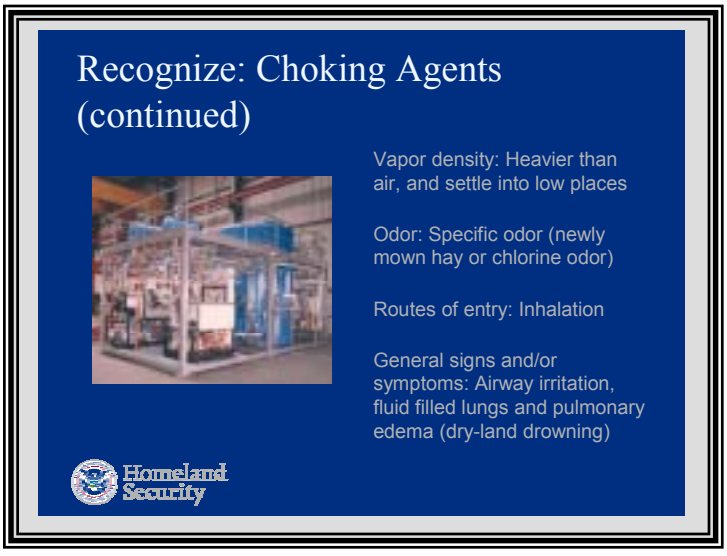
The next four sections of this module cover a class of chemicals called chemical warfare agents. Choking agents, nerve agents, blood agents, and blister agents are sub-classes of chemical warfare agents and are categorized as being lethal. While some of the chemical warfare agents are purposed for industrial uses such as choking agents (i.e., chlorine) others were solely designed for use as weapons of mass destruction on the battlefield (i.e. sarin or GB).

Choking Agents

Chemical warfare agents are classified according to their physiological affects or their military use. In the case of choking agents, the classification is based on the physiological affect. Phosgene (CG) and chlorine (Cl) are two that have been used as military agents. Both of these industrial chemicals are commercially available and could be obtained and used by terrorists.



- Type—Phosgene (**fōz**-jēn) (CG), chlorine (**klōr**-ēn) (Cl)
- Dissemination—Solid, liquid, or gas



- Availability—Commercially available; used in disinfectants, plastics, pesticides, solvents, chemical synthesis, plastics, pesticides, dyes, and herbicides
- Volatility—Non-persistent, meaning it rapidly disperses after its release and only poses immediate, short-duration hazards (e.g., hours)
- Vapor density—Heavier than air, it will settle into low places

- Odor—Victims may mention a specific odor (newly mown hay or chlorine odor), but this is not always the case. Individuals must evacuate the area if they detect odor to avoid the physiological impact of the agent
- Routes of entry—Inhalation
- General signs and/or symptoms—Primarily attack the airway and lungs, causing irritation of the entire airway from the nose to the lungs. Fluid fills the lungs and pulmonary edema occurs; known as dry-land drowning. Onset of symptoms usually occurs immediately

Recognize: Blood Agents (Cyanides)

- Type—Hydrogen cyanide (**sī**-ŭh-nīd) (AC), cyanogen (sī-**ăn**-ə-jən) chloride (**klōr**-īd) (CK)
- Dissemination—Liquid or gas
- Availability—Commercially available; used in various manufacturing processes, such as electroplating, metallurgy, metal cleaning, and photography
- Volatility—Non-persistent, meaning it rapidly disperses after its release and only poses immediate, short-duration hazards (e.g., hours)

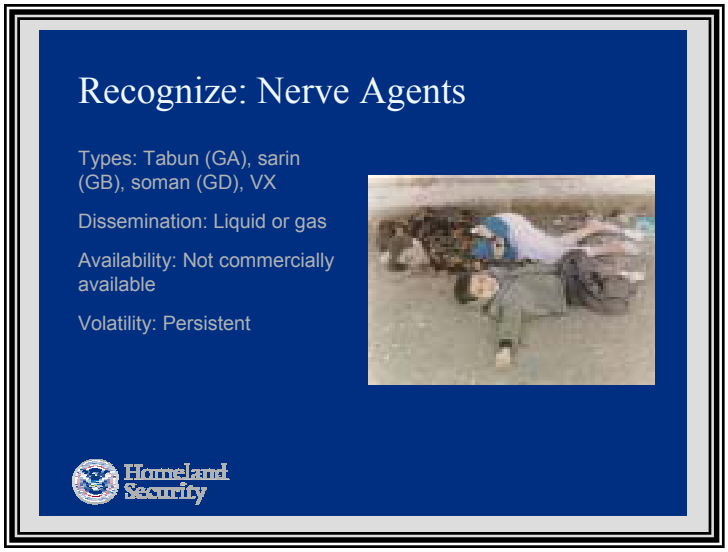
- Vapor density—Range from slightly lighter than air to significantly heavier than air
- Odor—Bitter almonds (peach pits)
- Routes of entry—Inhalation
- General signs and/or symptoms—Gasping for air, frothing or vomiting, losing consciousness, and dying; onset of symptoms occurs very rapidly, within seconds

Recognize: Blister Agents

- Type—Mustards (**mŭs**-tərds) (H) (referred to as mustard agents), lewisite (**lōō**-ĭ-sīt) (L), phosgene, oxime (**ŏk**-zēm) (CX); of this group, mustard (H) is the most likely to be used, as it is the easiest to produce
- Dissemination—Liquid
- Availability—Not commercially available; however some countries may have military stockpiles

- Volatility—Most are relatively persistent, meaning the agent, either in a vapor or liquid form, pose a contact or inhalational threat by being slow to evaporate
- Vapor density—Heavier than air
- Odor—Onions, garlic, or horseradish (mustard); geraniums (lewisite); intense and irritating (phosgene oxime)
- Routes of entry—Inhalation, ingestion, or absorption
- General signs and/or symptoms—Mustard agent exposure (no effects for hours) lewisite and phosgene oxime produce pain (effect seen immediately); severe itching and blisters, tearing/inflammatory reactions begin to appear immediately or up to several hours after exposure, causing pain, extreme light sensitivity, and spasmodic winking, bloody diarrhea, nausea, vomiting, and extreme weakness, nasal secretions, hoarseness, progressive coughing, loss of voice, and difficult breathing; gastrointestinal effects result in the destruction of mucus membranes; shock is possible. Onset of symptoms may not appear for hours with mustard agents; but other blister agent signs/symptoms onset will occur immediately

Recognize: Nerve Agents



- Type—Tabun (**tā**-bŭn)(GA), sarin (**săr**-ĭn) (GB), soman (**sō**-mən) (GD), VX (vē ĕks)
- Dissemination—Liquid or gas
- Availability—Not commercially available; however some countries may have military stockpiles
- Volatility—Tabun, sarin, soman—Non-persistent, meaning it rapidly disperses after its release and only poses immediate, short-duration hazards (e.g., hours); VX—Persistent, meaning the agent poses a contact or inhalational threat by being slow to evaporate

- Vapor density—Heavier than air
- Odor—Slightly fruity (tabun), faintly sweet (sarin), camphor (soman), odorless (VX)
- Routes of entry—Inhalation or absorption
- General signs and/or symptoms—Pinpointed pupils, respiratory arrest, sweating, weakness, disorientation, diarrhea, slurred speech, nausea/vomiting/drooling, trembling, paralysis, depression, abdominal pain, respiratory failure/depression, vomiting, headache, reduced vision, convulsions, general increase in secretions, tremors. Onset of symptoms occurs immediately. Some of these symptoms are known by the acronym SLUDGEM: salivation, lacrimation, urination, defecation, gastric distress, emesis and miosis

Case Study:

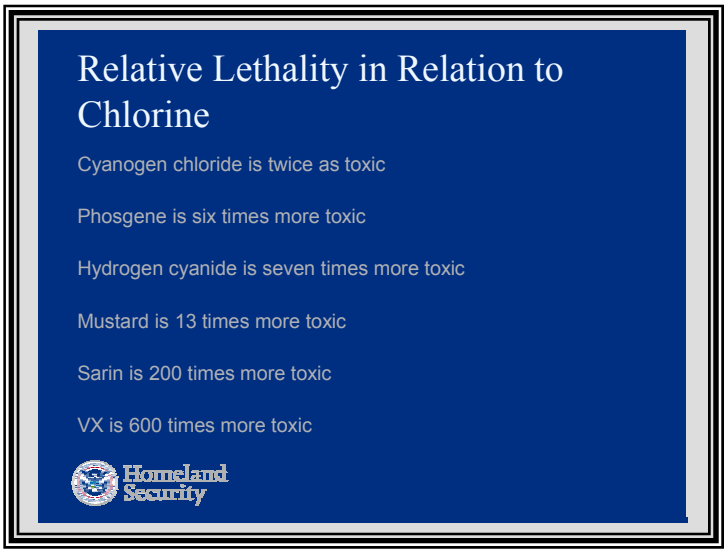
In the city of Halabja (hə-**lăb**-jə), Iraq, in March, 1988, over the course of several days, Iraqi warplanes and helicopters dropped onto a population of 60,000 a "cocktail" of mustard, nerve, and possibly blood agents. This chemical drop, directed by Saddam Hussein, resulted in the deaths of over 5,000 victims, most of whom were women and children. Thousands more received irreparable injuries to the skin, eyes, and the membranes of the nose, throat, and lungs. Many of those killed and injured were on the roads leading out of Halabja where Iraqi pilots, having anticipated an evacuation from the city, showered the roadways with chemical munitions.

Case Study:

In 1995, Aum (ə-**um**) Shinrikyo (shĭn-**rē**-kyō), a religious sect in Japan, released sarin in the Tokyo subway system, killing 11. A total of 5-6,000 persons were exposed. 3,227 went to the hospital, of whom 493 were admitted to 41 of Tokyo's many hospitals. Liquid sarin (a single drop of sarin the size of the head of a pin can kill an adult), contained in plastic bags wrapped in newspapers, each containing one liter, were delivered by five teams. The packages were placed on five different subway trains in the Tokyo subway system. Carrying their packets of sarin and umbrellas with sharpened tips, the terrorists boarded their appointed trains; at prearranged stations, each one dropped his package and punctured it several times with the sharpened tip of his umbrella. As the liquid spread out and evaporated, vaporous agent spread throughout the car. On the day of the disaster, 641 victims were seen at St. Luke's International Hospital. Among those, five victims arrived with cardiopulmonary or respiratory arrest with marked miosis (mī-**ō**-sĭs) and extremely low serum cholinesterase (ko-lən-**ĕs-**tə-rās) values; two died and three recovered completely. In addition to these five critical patients, 106 patients, including four pregnant women, were hospitalized with symptoms of mild to moderate exposure. Other victims had only mild symptoms and were released after six hours of observation.

Relative Lethality in Relation to Chlorine

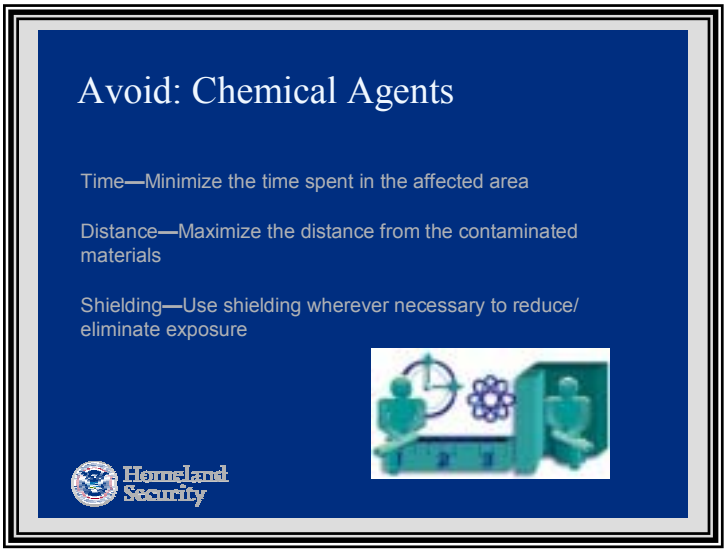
The following information is a representation of the approximate lethality of the agents in relation to chlorine. If chlorine is used as a baseline, then:



- Cyanogen chloride is twice as toxic
- Phosgene is six times more toxic
- Hydrogen cyanide is seven times more toxic
- Mustard is 13 times more toxic
- Sarin is 200 times more toxic
- VX is 600 times more toxic

For skin toxicity, one to two grams of mustard or sarin or 10 milligrams of VX are required. Skin toxicity for VX requires a quantity that is 100 to 200 times less than either mustard or sarin.

Avoid: Chemical Agents



Individuals should use the principles of time, distance, and shielding to avoid chemical agents. First, avoid obvious hazards.

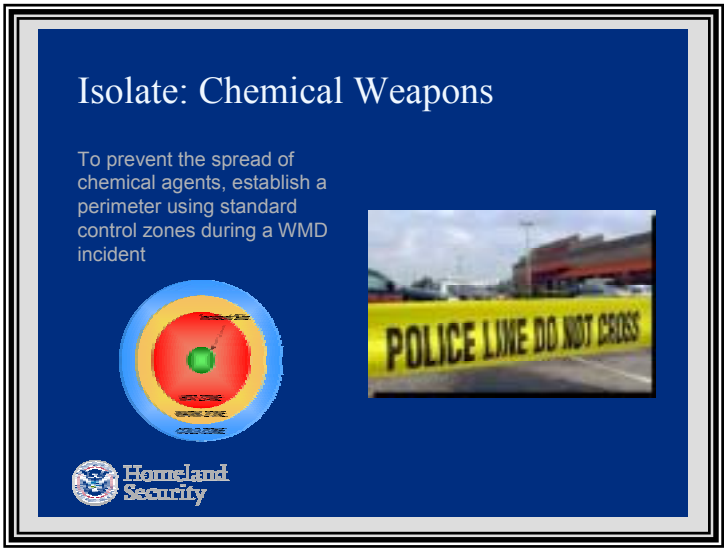
- *Time—Minimize the time spent in the affected area*. Evacuate the immediate area as soon as the presence of a chemical hazard is detected. Get out and stay out until the all clear signal is given

- *Distance—Maximize the distance from the contaminated materials*. The further one is from the hazard, the less likely the hazard will have any effect on life and mission capability. Evacuate upwind, uphill, and upstream to a distance specified in the *ERG* depending upon the chemical agent present

- *Shielding—Use shielding wherever it is necessary to reduce/eliminate exposure*. By placing an appropriate shield between the contaminant source and the individual (such as sheltering in place), some contamination and exposure may be completely eliminated or reduced to an acceptable level

Isolate: Chemical Agents

To prevent the spread of chemical agents, individuals should use standard control zones during a WMD incident.



Control Zones

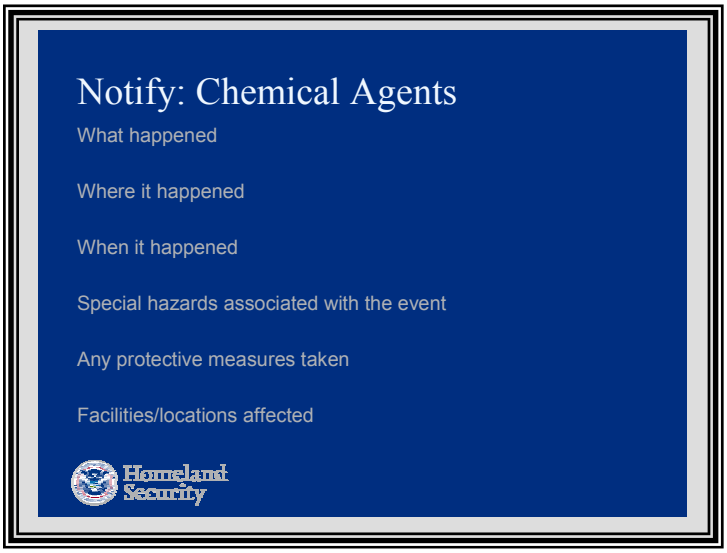
The designation of areas at the hazardous materials incident based on safety and the degree of hazard. Many terms are used to describe the zones involved in a hazardous materials incident.

- *Hot Zone*—area immediately surrounding a hazardous materials incident, which extends far enough to prevent adverse effects from hazardous materials releases to personnel outside the zone; also referred to as the exclusion or restricted zone

- *Warm Zone*—area where personnel, equipment decontamination, and hot zone support takes place; includes control points for the access corridor, and thus assists in reducing the spread of contamination; also referred to as the decontamination, contamination reduction, or limited access corridor

- *Cold Zone*—includes command post and other support functions deemed necessary to control the incident

Notify: Chemical Agents

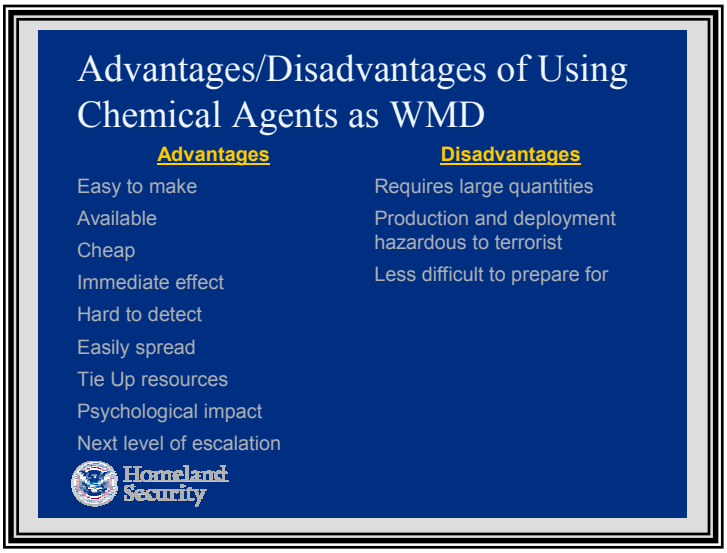


One must follow local protocols for notifying emergency services and emergency support personnel.

- What happened
- Where it happened
- When it happened
- Special hazards associated with the event
- Indicators of the type of hazard, the number of victims, and any witnesses
- Any protective measures taken
- Facilities and locations affected

Advantages/Disadvantages of Using Chemical Agents as WMD

Advantages



- Easy to make or acquire—The low cost and technology required to develop chemical weapons makes the manufacture of a chemical agent relatively simple to assemble. The ease of production of chemical agents has been compared to that of narcotics or heroin
- Available—Chemical agents can be obtained from military stockpiles, manufacturing processes, such as electroplating, metallurgy, metal cleaning, and photography

- Cheap—Chemical weapons have commonly been referred to as the "poor man's atomic bomb" due to their relative low cost and ease of manufacture. A group of chemical experts, appearing before a United Nations panel in 1969, estimated that for a large-scale operation against a civilian population, casualties might cost about $2,000 per square kilometer with conventional weapons, $800 with nuclear weapons, $600 with nerve-gas weapons, and $1 with biological weapons

- Immediate effect—Chemical agents have an immediate effect. The lethality increases as one nears the point of origin. This means the closer one gets to the source, the more incapacitated one becomes

- Hard to detect—Chemical agents can be odorless or without taste; makes them harder to detect

- Easily spread—Prevailing winds could carry the released chemicals over a populated area. Chemical agents may also be spread through explosives, sprayer systems, and in food and water contamination

- Tie up resources—The dissemination of chemical weapons require decontamination, combined efforts from all disciplines, and increasing media attention. Health care facilities, law enforcement, fire services, etc. will be exhausted during a chemical weapons attack

- Psychological impact—The psychological impact of chemical agents will extend far beyond the attack. Many people don't know much about chemical weapons, and fear them

- Next level of escalation—Use of chemical weapons, even if the agents are supposed to be "non-lethal," carries the inherent danger of escalation into an all out chemical war and heightened violence

Disadvantages

- Requires large quantities—In order to spread chemical agents effectively, large quantities are required. This is difficult, because acquiring large amounts of agent may be impossible due to the Chemical Weapons Convention

- Production and deployment hazardous to terrorist—Terrorists take great risk when developing weaponized chemical agents. Without proper protection, terrorists risk becoming a casualty

- Less difficult to prepare for—It is easier for America to prepare for a chemical attack as opposed to a radiological, biological, or explosive attack

Module Summary

- Describe toxic industrial chemicals used as weapons and the physiological signs and symptoms associated with them
- Describe choking agents and the physiological signs and symptoms associated with them
- Describe blood agents and the physiological signs and symptoms associated with them
- Describe blister agents and the physiological signs and symptoms associated with them
- Describe nerve agents and the physiological signs and symptoms associated with them