



CBRNE (WMD) Refresher

COL(Ret.) Brian G Canteel

Email: bgcanteel@gmail.com



Novichok Incident March 2018, Salisbury, England

CBRN (WMD)



- **C- Chemical Agents**
 - Chemical Warfare & Toxic Industrial Chemicals.
- **B – Biological Agents**
 - Bacterial, Virus, & Toxins
- **R – Radiological.**
 - Exposure to Radiation through a Radiological Dispersion Device- aka Dirty Bomb
- **N - Nuclear.**
 - Exposure to potential High Levels of Radiation from a nuclear detonation.
- **“E” Explosives.** The US Military still uses the term CBRNE

References

- **NFPA 470-2022 ed.** Hazardous Materials/Weapons of Mass Destruction(WMD) for Responders. Consolidates NFPA 1072, 472 & 473.
- **OSHA 29 CFR 1910.120(q) HAZWOPER**
- **FEMA 2017 NIMS. Resource Typing:**
 - ✓ Hazardous Materials Response Team (Rev March 2020)
 - ✓ Hazardous Materials Technician (Rev. March 2020).
 - ✓ Hazardous Materials Officer (March 2018)
- **US HHS Technical Resources, Assistance Center, and Information Exchange (TRACIE)**
- **US HHS Radiation Emergency Medical Management (REMM)**



Chemical Agents

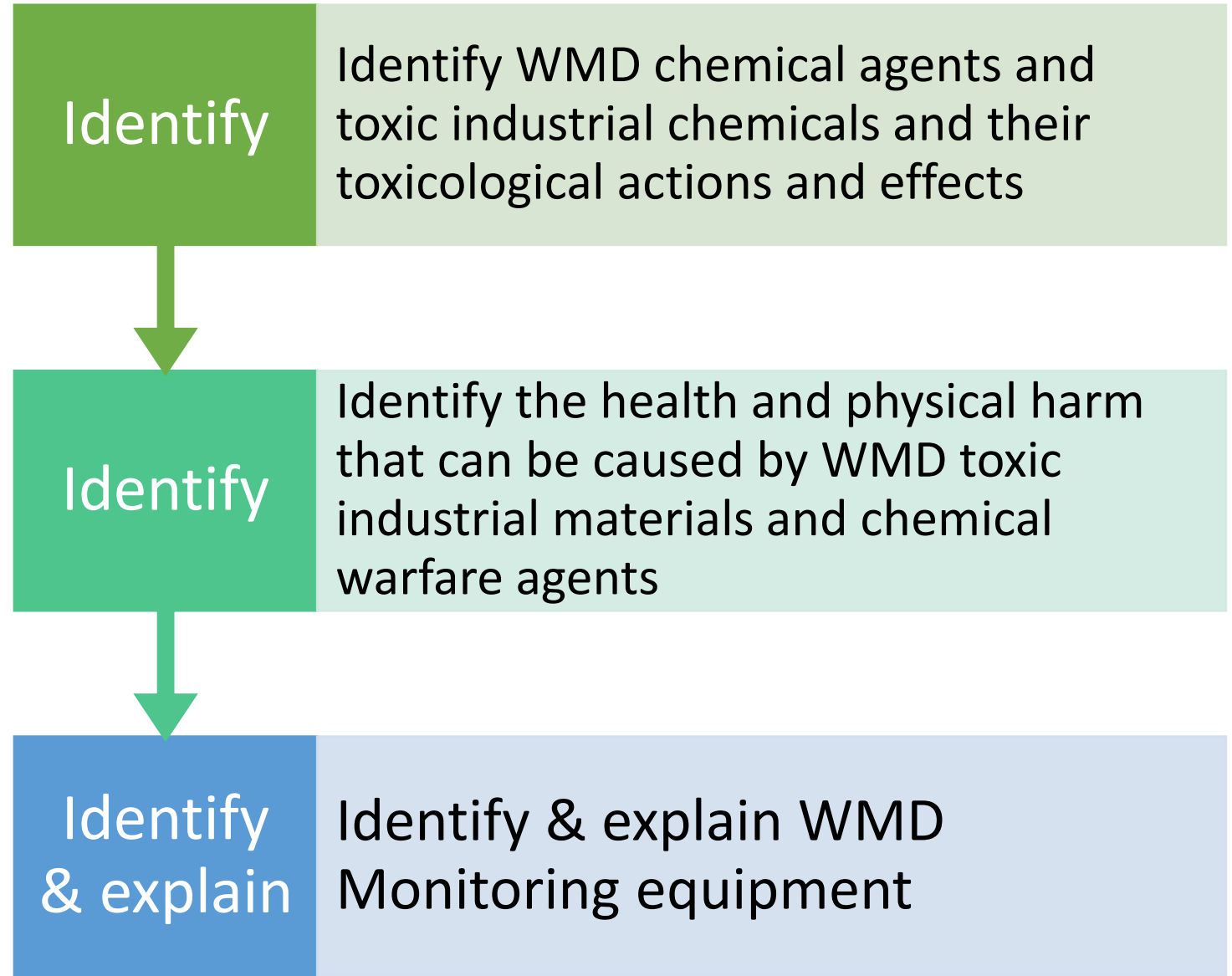
**Chemical Agents
&**

**Toxic Industrial
Chemicals(TIC)**



Blister Agent

Learning Objectives

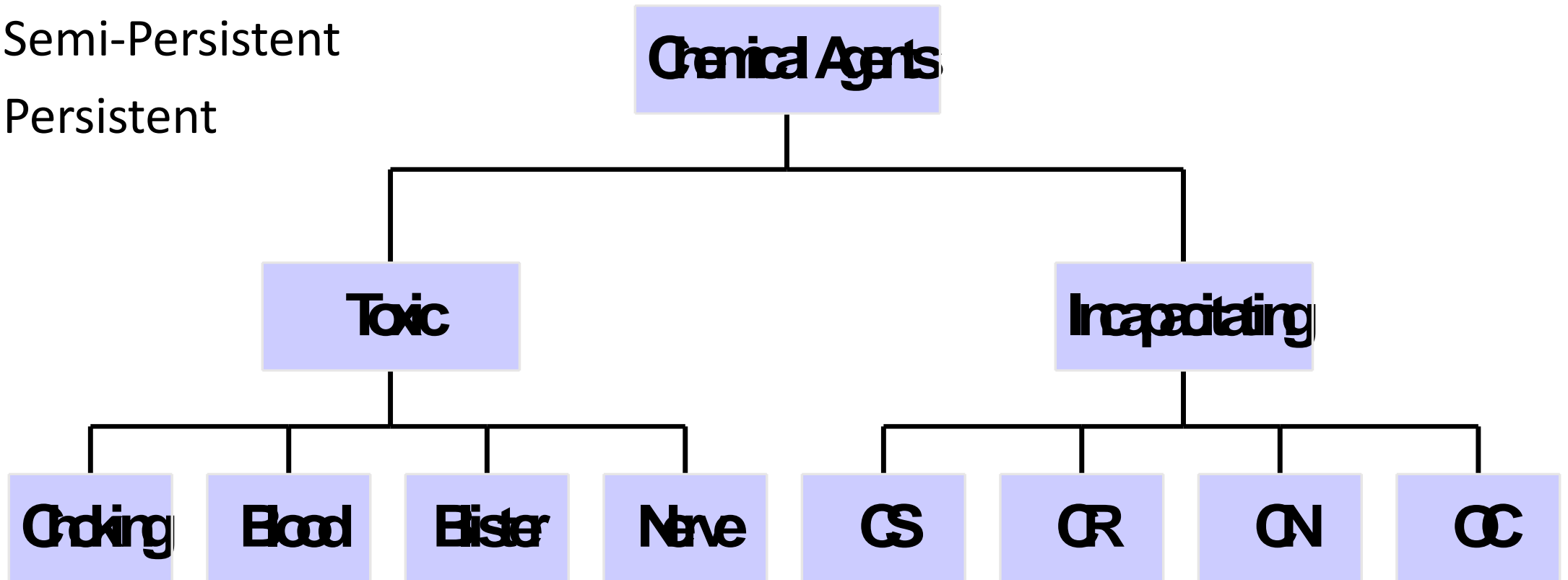


Standards

- **OSHA 29 CFR 1910.120(q)**
HAZWOPER
- **NFPA 470-2022. Hazardous Materials/Weapons of Mass Destruction for Responders**
- **DHS/FEMA NIMS 2017 National Qualification Standards(NQS)**

CLASSES OF CHEMICAL AGENTS

- Non Persistent
- Semi-Persistent
- Persistent





CHOKING AGENTS

Phosgene (CG)
& Chlorine (Cl₂)

- **Characteristics:**
 - Presents as gas or liquid that readily evaporates
 - Highly toxic with immediate and delayed symptoms
 - *Much heavier than air*
- **Routes of Exposure:** Inhalation & Eyes/Skin
- **Signs & symptoms**
 - Fluid builds up in lungs & victim chokes on own fluid- Pulmonary edema
 - Blurred vision, Watery eyes, Chest tightness
 - Choking, Coughing, & Vomiting
 - Victim can die of oxygen deficiency
 - Clinical signs of pulmonary edema will typically present 2-4 hours
- **First Aid.** Treatment is supportive - there are no specific antidotes for Phosgene & Chlorine
- **Form When Disseminated:** Gas
- **Rate of Action:** Immediate, symptoms will get worse with time. Low concentration exposure symptoms develop within 4-24 hours
- **DECON:** Flushing with water & aeration

BLOOD AGENTS

Phosgene(CG)
Hydrogen

Hydrogen
Cyanide(AC)

Cyanogen
Chloride(CK)

Arsine (SA)

- **Characteristics:** Due to the high degree of volatility of these compounds, the liquid rapidly vaporizes & disperses.
- **Routes of entry:** Inhalation & Eyes/Skin
- **Signs & Symptoms:**
 - Convulsions, Difficulty breathing, Dizziness, Headache
 - Increase heart rate, increase rate of breathing, Nausea, & Vomiting
- **Form when disseminated:** Gas
- **Rate of Action:** Immediate (within seconds)
- **DECON:** Soap & Water **First Aid:** Amyl Nitrate



**US Field Artillery 155mm HD
Mustard Gas Projectiles**

Blister Agents (Vesicants)

Mustard(HD), Nitrogen Mustard (HN)
Lewisite (L) & Phosgene oxime (CX)

-
- **Characteristics:**
 - Health effects develop slowly over hours
 - Skin contact effects occur quicker than inhalation effects
 - Vapor density varies
 - **Routes of entry: Absorption, Inhalation & Eyes/Skin**
 - **Signs & Symptoms:**
 - Blistering delayed, Convulsions, Difficulty breathing, Fatigue
 - Hoarseness, Nausea & Vomiting, Respiratory distress leading to respiratory failure
 - **Form when disseminated: Liquid with high viscosity**
 - **Rate of Action: Delayed**
 - **DECON:** Clothing removal, flush with water, DECON solution of 0.5% bleach

Sulfur Mustard Gas, H or HD

- Although it was first made in the 19th century, it was developed by Haber and other German chemists to be used as a weapon.
- Called “mustard” because of its horseradish- or garlic-like smell.
- It is fat-soluble, so it dissolves in the oils in the skin, causing severe chemical burns and blisters.
- “**H**” usually refers to an impure form of sulfur mustard with 20-30% impurities...has short shelf-life. It is relatively easy to make
- “**HD**” refers to a more-pure form (96% pure) that can be stored longer



Sulfur Mustard Treatment

- Early rinsing of the exposed area with Betadine (povidone-iodine) dissolved in glycofural will reduce symptoms.
- Can limit the formation of blisters by applying household bleach or a solution called DS2 (2% sodium hydroxide, NaOH, 70% diethylamine, and 28% ethylene glycol monomethyl ether).
- After initial treatment, the patient is treated in the same way that any burn victim would be treated.
- Because the symptoms do not appear for about 24 hours, it is less likely that the treatments would be done in time to avoid problems.
- Fatal in about 2% of (military targets) exposures, so mostly used as an incapacitating agent.

Lewisite (L)

- Route of Entry; Inhalation, Eye/Skin, Ingestion
- Dissemination. Aerial Spray
- Characteristics:
 - Boiling Point-374 F
 - Vapor Density 7.1 (Air = 1.0)
 - Specific Gravity 1.88 at 68 F
 - Classified as a **Persistent CWA**
- Easily penetrates ordinary clothing
- Upon skin contact immediate pain and itching with a rash and swelling. Large blisters (similar to those caused by mustard gas) develop after approximately 12 hours
- Can cause systemic poisoning leading to liver damage or death.
- Inhalation causes a burning pain, sneezing, coughing, vomiting
- Ingestion results in severe pain, nausea, vomiting, and tissue damage.
- Oily, colorless liquid in its pure form and can appear amber to black in its impure form



Nerve Agents

Tabun (GA), Sarin (GB), Soman (GD), Cyclosarin (GF) & VX

- **Characteristics:** Aerosolization is the most effective way to weaponize nerve agents
- **Routes of entry:** Inhalation, Eyes. VX due to very low VP Skin absorption
- **Signs & symptoms:**
 - Convulsions, Difficulty breathing, Fatigue, Loss of consciousness, Muscular twitching, Nausea
 - Pinpoint pupils, Respiratory secretions, Runny nose, Seizures, Sweating, Temporary breathing storage

Form when disseminated: Liquid, Vapor or Aerosol

Rate of action: Immediate

First Aid: Mark 1 Nerve Agent Kit

DECON: Clothing removal, flush with bleach & water (0.5% solution)

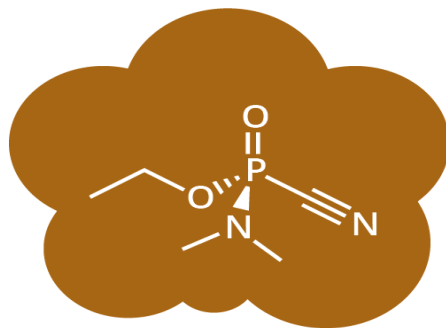


Syrian Reporter Exposed to Nerve Agent

CHEMICAL WARFARE NERVE AGENTS

PART ONE: THE G SERIES

THE G SERIES NERVE AGENTS ARE SO NAMED BECAUSE THEY WERE ALL FIRST SYNTHESISED IN GERMANY. THEY ARE ALL EXTREMELY TOXIC VOLATILE LIQUIDS, CLASSIFIED AS WEAPONS OF MASS DESTRUCTION BY THE U.N., AND THEIR PRODUCTION & STOCKPILING IS OUTLAWED.



TABUN (GA)

(ethyl dimethylphosphoramidocyanidate)

SMELL & APPEARANCE

Clear, colourless liquid, though impure tabun can have a brown appearance. Pure tabun is odourless, but it often has a faint 'fruity' odour due to impurities.

SYNTHESISED

1936

Discovered accidentally by Gebhardt Schrader, a German chemist who was investigating organophosphates as pesticides.

LETHALITY

median lethal concentration

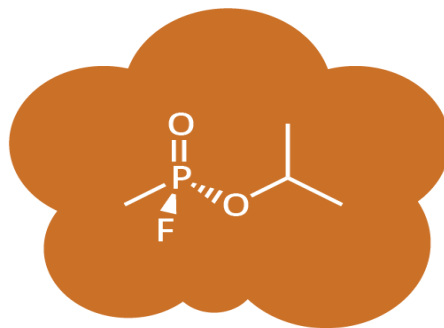
400

milligram-minutes per cubic metre

median lethal dose

4000

milligrams per person (skin exposure)



SARIN (GB)

(isopropyl methylphosphonofluoridate)

SMELL & APPEARANCE

A clear, colourless liquid, tasteless and odourless in its pure form. It's a volatile liquid; like other nerve gases the vapour generated is heavier than air.

SYNTHESISED

1938

Named after the team of scientists behind its initial discovery: Schrader, Ambros, Ritter & Van der Linde

LETHALITY

median lethal concentration

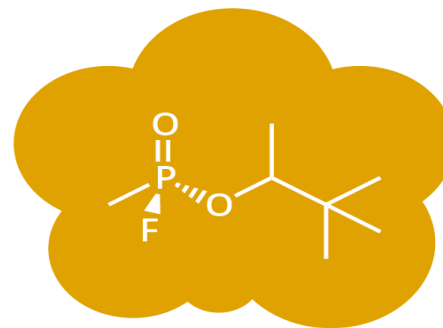
100

milligram-minutes per cubic metre

median lethal dose

1700

milligrams per person (skin exposure)



SOMAN (GD)

(3,3-dimethylbutan-2-yl methylphosphonofluoridate)

SMELL & APPEARANCE

Soman is a clear, colourless, tasteless liquid. Its odour is faint when pure, but when impure it has a yellow-brown colour and has a strong, camphorous odour.

SYNTHESISED

1944

Discovered during research into the pharmacology of tabun & sarin funded by the German army.

LETHALITY

median lethal concentration

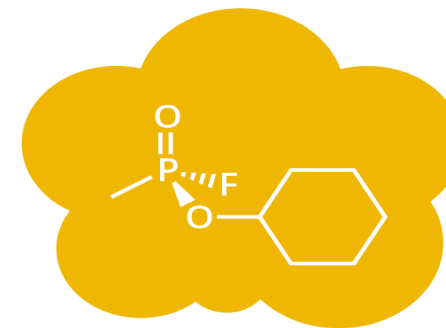
70

milligram-minutes per cubic metre

median lethal dose

300

milligrams per person (skin exposure)



CYCLOSARIN (GF)

(cyclohexyl methylphosphonofluoridate)

SMELL & APPEARANCE

Clear, colourless liquid with a sweet, musty smell, sometimes likened to peaches. It evaporates around 70 times slower than sarin, and is also flammable.

SYNTHESISED

1949

Also a result of German research, Iraq is the only country known to have manufactured significant quantities.

LETHALITY

median lethal concentration

50

milligram-minutes per cubic metre

median lethal dose

350

milligrams per person (skin exposure)

EFFECTS OF NERVE AGENTS



Inhibit breakdown of acetylcholine



Cause contraction of the pupils



Excessive mucus, tears, saliva & sweat



Nausea, gastrointestinal pain & vomiting



Bronchoconstriction & chest tightness



Spasms, convulsions & loss of bowel control



Coma & eventual death



© COMPOUND INTEREST 2014 - WWW.COMPOUNDCHEM.COM | Twitter: @compoundchem | Facebook: www.facebook.com/compoundchem
Shared under a Creative Commons Attribution-NonCommercial-NoDerivatives licence.



Tabun (GA)



CWA Found in Syria

- First synthesized in 1936
- Faint fruity odor...harder to detect than chlorine, phosgene, mustard gas, and hydrogen cyanide, which have more distinctive odors...troops less likely to put on gas masks
- Duration: Semi-Persistent
- Dissemination. Aerial Spray or Water Contamination
 - Vapor Density: 5.6 (Air = 1)
 - Specific Gravity: 1.073 (Water = 1)
 - Readily mixes with water
- **First Aid:** Mark One Nerve Agent Kit
- **DECON:** Bleach, Soap & Water Easier to produce than the other G-series agents

Sarin (GB)



**US Army Sarin Nerve Gas
Artillery Shells at Blue
Grass Army Depot**

- Developed by the Germans in 1938
- Odorless & Colorless
- Dispersion: Gas
 - Vapor Density: 4.86 (Air = 1)
- Harder to make than tabun. If sarin does not have a high purity, it degrades fairly rapidly.
- More stable than tabun(handling)
- More volatile than tabun
- Duration: Non-Persistent Agent
- ***Six(6) times as potent as tabun***
- First Aid: Mark One Nerve Agent Kit
- DECON: Bleach, Soap & Water
- Adopted as the standard nerve agent for the U.S. in 1948.

Soman (GD)



- Developed by the Germans in 1944
- Twice as potent as sarin
- Smells like rotting fruit
- **APPEARANCE:** Clear, colorless, liquid. Discolors with aging to dark brown. Gives off colorless vapor
- Dissemination: Aerial Spray or Gas
 - Vapor Density: 6.3 (Air =1)
- Easily penetrates skin
- First Aid: Mark One Nerve Agent Kit
- DECON: Bleach, Soap & Water
- Slower to evaporate than sarin
- Duration: Semi-persistent Agent
- Lack of reliable antidote, making it more difficult treat accidental exposure

VX

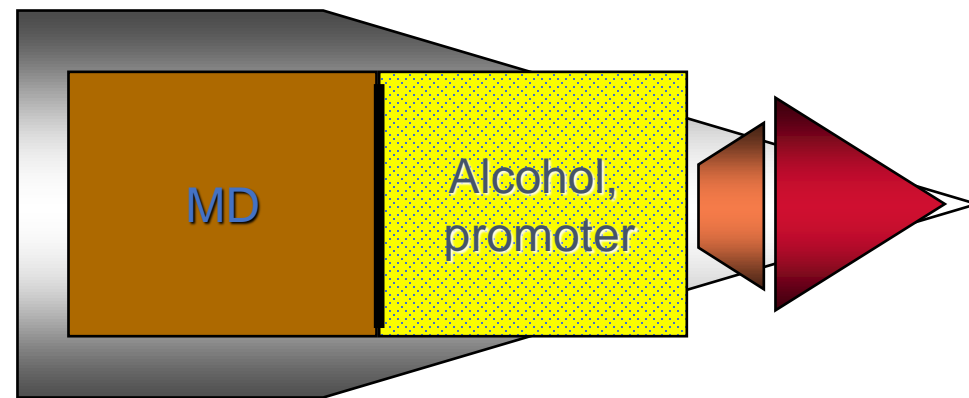


VX Nerve Agent
Storage Cylinder

- One of several similar substances that were considered “venomous” and called V-agents.
- First produced in England in 1954
- Clear, amber-colored, oily liquid. Odorless, slightly more dense than water, with a viscosity similar to motor oil
- Three times(3X) more toxic than sarin when inhaled and a thousand times more toxic when absorbed by the skin. A small drop on the skin could kill an adult in fifteen minutes.
- Dispersed as an airborne mist or coarse spray.
- Clings to whatever it hits
- Duration: Persistent
- DECON; Bleach & Water
- When sprayed on the ground, remains lethal for up to three weeks, so it is an *area denial weapon*.
- **Note containers can explode when heated**

Binary Chemical Weapons

- In order to minimize the dangers associated with the handling and storage of a nerve gas, the last step in its production can take place after a projectile is launched.



**Binary Mortar or
Artillery Projectile**

Russia's Novichok (no-wee-shok)

4th Generation Nerve Agent

- Novichok (new guy or newcomer) is a series of nerve agents developed by the Soviet Union and Russia between 1971 and 1993. Five Novichok variants are believed to have been adapted for military use. The most versatile is A-232 (**Novichok-5**).
- Intent was to develop binary agents that could be made from relatively safe substances similar to normal industrial substances, making it easier to conceal the production
- More lethal than VX
- Resistant to treatment
- **Forms.** Novichok agents may be dispersed as an ultra-fine powder as opposed to a gas or a vapor
- **Onset.** Novichok is reported to be 5–8 times more lethal than VX nerve agent and effects are rapid, usually within 30 seconds to 2 minutes
- **Antidotes:** Pralidoxime, Diazepam. (CANA — Convulsant Antidote for Nerve Agent)

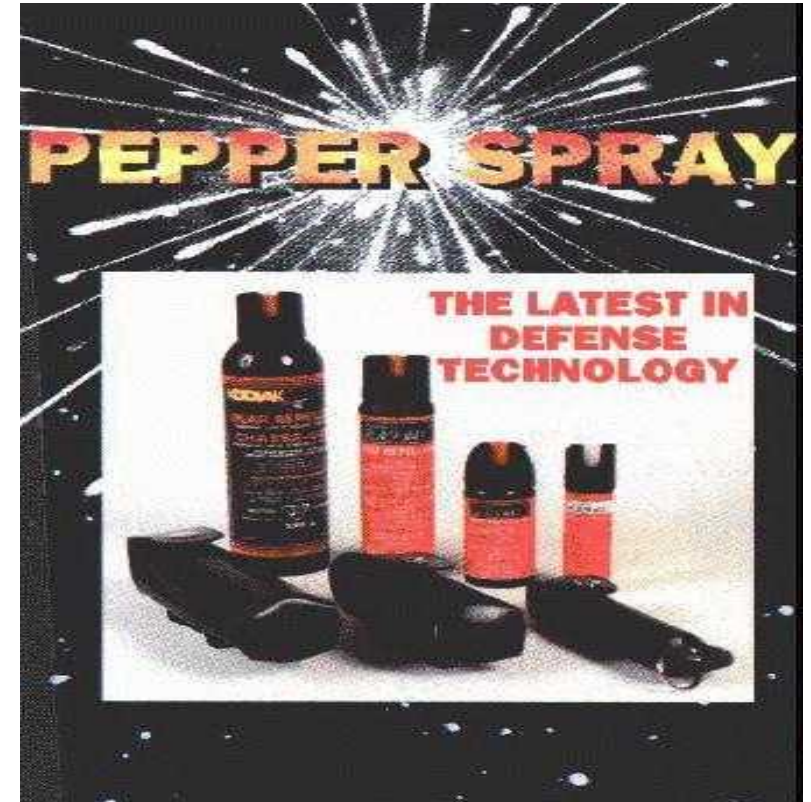
Nerve Agent Antidotes

- Atropine and 2-PAM can be administered with a pressurized syringe with a spring-loaded, recessed needle. Mark 1 Kit
- Diazepam (CANA — Convulsant Antidote for Nerve Agent)
 - Use of Diazepam is for actively seizing patients; therefore, it is not intended for self-administration.
 - Diazepam should be administered with the three MARK I kits when the casualty's condition warrants the use of three MARK I kits at the same time



IRRITANTS OR RIOT CONTROL AGENTS

- CS (tear gas)
- SR (tear gas)
- CN (mace)
- OC (pepper spray)

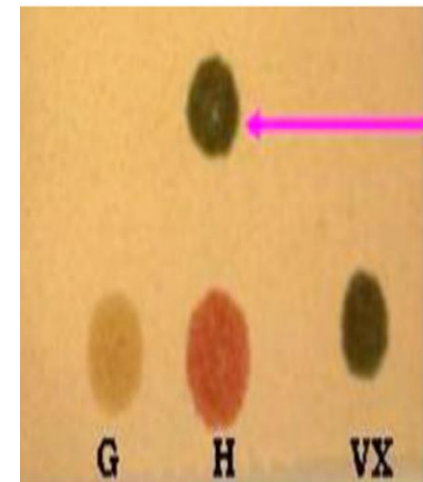


How Do We Detect Chemical Weapons?

- M-8 Chemical Agent Detection Paper
- M-9 Chemical Agent Detection Paper
- M256 A1 Kit (Vapor)
- Multi-Gas Monitor with PID
 - MultiRAE Lite & MultiRAE Pro
- Flame Photometric Detector(FPD)
 - AP2C
- Fourier transform infrared (FT-IR)
 - HazMat ID, HazMat ID 360, & GasID
- Raman Spectroscopy
 - AHURA-First Defender
- Surface Acoustic Wave (SAW) Detector
 - SAW MiniCad

M-8 Chemical Detection Paper

- Two dyes and one pH indicator on paper
- Blotted on liquids that arouse suspicion. It identifies CAs by changing colors within 30 seconds of exposure.
- Nerve agent yellow
- Mustard agent red
- VX causes the indicator to turn to blue which, together with the yellow, will become green/green-black.
- Reaction in approx. 30 seconds
- Improved M-8 paper detects Forth Generation Nerve Agents (FGA) issued to us army units starting in 2023



← FGA spot



← FGA spot

M-9 Detection Paper

- M9 paper has adhesive backing that allows it to be attached to clothing and equipment.
- M9 paper is a disposable, hand-held device that detects the presence of G, V, or H agents in liquid form only.
- It can produce **false positives** when used on hot, dirty, oily, greasy surfaces, petroleum products, or DS2.
- **Color change** (Red, Reddish brown, Pink, Purple) indicates chemical agent but does not identify a specific agent
- Tends to react faster than M8 paper
- Shelf Life up to 8 years



M256A1 Kit (Vapor)

- Detects nerve, blister, and blood agents as well as lewisite
- Used in initial reconnaissance
- Take 17 minutes to complete
- Very sensitive with few false positives



Multi-Gas Monitor with PID

- O₂, LEL, H₂S, Nitric Oxide, & Bromine & iodine4-gas sensors with PID
 - Standard sensor package: O₂, LEL, H₂S & CO
- MultiRAE Pro & AreaRAE have a Gamma meter
- PID detect presence of VOCs
 - Detects some inorganics materials (ammonia)
 - Ionization Potential (IP) 10.6eV
 - Detection range 0-5,000 ppm
- Detects organic pesticides: aldicarb, Sarin and VX
- Detects inorganics: Ammonia, Arsine & Phosphine



Flame Photometric Detector(FPD)

- Detects nerve and blister agents and some toxic industrial chemicals
- FPD Monitor: AP2C
- Detects: GA, GB, GD, GF, VX, HD, H, & HT
- **Application:**
 - Initial reconnaissance
 - Sample screening
 - DECON efficiency
 - Displays detection signal of substance in air

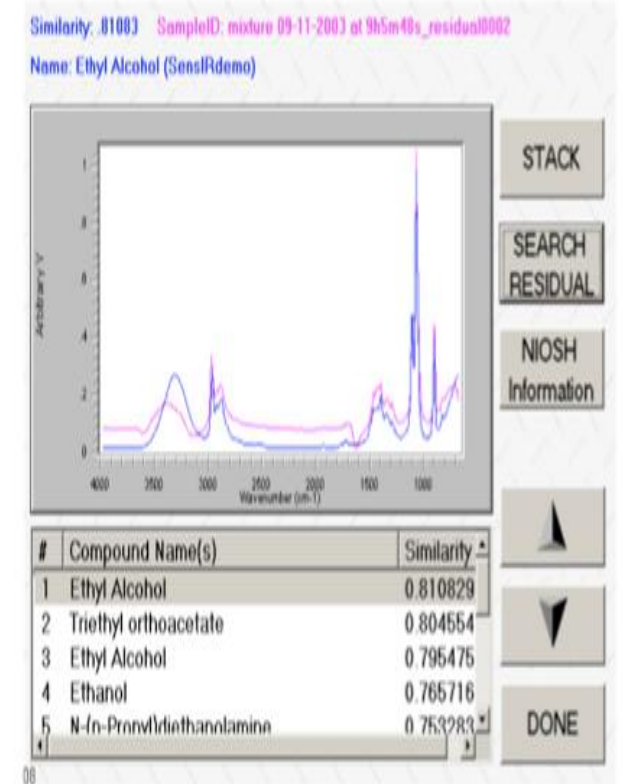
Limitations

- Not inherently safe, except the “E” model
- Operator training needs



Fourier transform infrared (FT-IR)

- **Monitors:** HazMatID, HazMatID 360, GasID
- IR radiation used to excite molecules
- Each agent absorbs unique wavelengths and yields a unique pattern referred to as a fingerprint
- Detects: WMD-nerve & blister agents, Toxic Industrial Chemicals, White Powders, Explosives & Clan Lab precursors, & Pesticides



Raman Spectroscopy

AHURA-First Defender

- **Detects chemical warfare agents, TICs, and common white powders**
 - Solids & liquids
 - May not have to open containers
 - Uses a class 3B laser

Application

- Point-and-shoot
- Sample vial compartment
- Organic & inorganic water based solutions

Limitations

- Dark-colored samples
- Fluorescence
- Not intrinsically safe and potentially explosive



Surface Acoustic Wave Detector

- Have chemically selective coated piezoelectric crystals that absorb target gases. Able to identify resonant frequency changes and measured by a microcomputer
- Able to identify and measure many chemical agents simultaneously
- Inexpensive
- Model: SAW MiniCAD mk II



Review & Questions

- Chemical Agents
 - ✓ Choking
 - ✓ Blood
 - ✓ Blister
 - ✓ Nerve
 - ✓ Binary Chemical Weapons
- Chemical Agent Detectors
- Nerve Agent Antidotes

Biological Warfare Agents

Bioterrorism Agents/Diseases

- **Emergency Preparedness**
- The U.S. public health system and primary healthcare providers must be prepared to address various biological agents, including pathogens that are rarely seen in the United States. High-priority agents include organisms that pose a risk to national security because they:
 - ✓ Can be easily disseminated or transmitted from person to person;
 - ✓ Result in high mortality rates and have the potential for major public health impact;
 - ✓ Might cause public panic and social disruption; and
 - ✓ Require special action for public health preparedness.
- ✓ Grouped into Categories; A, B & C
- ✓ **References; NFPA 470 -2022 ed and FEMA NIMS 2018**

Biological Warfare Agents

• Learning Objectives

- Identify & define key terms germane to biological agents and incidents
- List & explain the four major categories of biological threat agents.
- Provide examples of components used in biological agent's production.
- List & explain key biological pathogens listed in CDC Category A, B & C
- Recognize the hazards and indicators of a biological incident.

Biological Warfare Agents

Emergency Responder Protocols

- **Approach from and remain upwind, uphill, and upstream.**
- **Isolate immediate area at least 75 feet in all directions.**
- **Treat all suspected affected individuals as contagious.**
 - ✓ Increase PPE Level. (PAPR or SCBA)
 - ✓ Minimize exposure and product contact
- **DECON**
 - ✓ Surfaces with 0.5% bleach solution
 - ✓ Individuals and animals with soap & water

Components Used in Bio Agent Production



Improvised Fermenter



Mini Lab Centrifuge



Bioreactor

Syringe Filter



Scientific Incubator



Petri Dish



shutterstock.com • 417253468

Key Biological Agents and Incident Terms

- Particle size
- Infectious dose
- Spore
- Prophylaxis
- Index case
- Endemic
- Zoonotic

Biological Agents

○ **BACTERIA**

○ **VIRUSES**

○ **TOXINS**

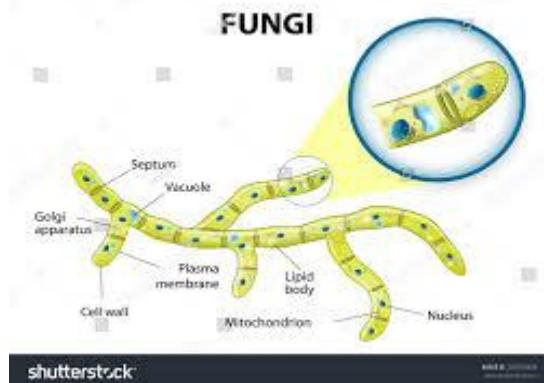
○ **Fungi**



Bacteria



Castor Bean Plant



Virus

Biological Agents: Properties

- **Result in slower appearance of signs/symptoms than chemical agents.**
 - ✓ May take days or weeks to manifest signs & symptoms.
- **Inhalation is primary route of exposure.**
 - ✓ Ability of biological agent to remain airborne is a critical factor.
- **Most will not penetrate intact skin.**
 - ✓ However particles containing a biological agent enter through eyes, nose or mouth.

Biological Agents

METHODS OF DISSEMINATING BIOLOGICAL AGENTS

- Aerosol
- Ingestion
- Dermal Penetration



Biological Warfare Agents

BACTERIA - Single-celled organisms which cause a variety of diseases in animals, plants, and humans. They may also produce extremely potent toxins inside the human body.

- ✓ **Anthrax**

- ✓ **Plague** (Bubonic & Pneumonic)

Rickettsia- Rickettsia are a class of cellular life smaller than bacteria, but larger than viruses. Rickettsia can only multiply inside live cells. They cause diseases such as Q fever and typhus.

- ✓ **Q Fever**

- ✓ **Typhus**

Biological Agents: Anthrax

(Bacterial)

- **Routes of Entry**

- ✓ Skin (open or unhealed wound)
- ✓ Digestive
- ✓ Respiratory

- **Symptoms:**

- ✓ Onset within 7 days
- ✓ Itching, Lesions, Fever,
- ✓ Fatigue, & Non-Productive Cough
- ✓ Chest Discomfort.

- **Treatment-antibiotics within 1-6 days**

- ✓ Vaccine-limited effectiveness

- **Mortality:**

- ✓ 5-20% (untreated cutaneous)
- ✓ 25 - 75% for gastrointestinal
- ✓ 80 + % for inhalation)



Biological Agents: Plague (Bacterial) Bubonic & Pneumonic

- **Plague is a disease caused by *Yersinia pestis* (*Y. pestis*), a bacterium found in rodents and their fleas in many areas around the world**
 - ✓ Pneumonic plague can be transmitted from person to person; bubonic plague cannot
- **Routes of Entry**
 - ✓ **Bubonic**: Penetration. Bites from fleas from infected rodents **or** exposure to infected material through a break in the skin.
 - ✓ **Pneumonic**. Respiratory. Infected human or animal
 - ✓ **Infected person considered contagious****
- **Symptoms:**
 - ✓ **Onset within 1-6 days**
 - ✓ **High Fever,**
 - ✓ **Bubonic**. Painful/swollen lymph nodes (armpits & neck)
 - ✓ **Pneumonic**. Patients usually have fever, weakness, and rapidly developing pneumonia with shortness of breath, chest pain, cough, and sometimes bloody or watery sputum. Nausea, vomiting, and abdominal pain may also occur
- **Treatment-antibiotics.** Rapid use of Antibiotics



Biological Agents: Q Fever (Bacterial/Rickettsia)

- **Q Fever may be considered a bioweapon because of its potential as an incapacitating agent.**
- **Routes of Entry:**
 - ✓ Inhalation
 - ✓ Ingestion
- **Symptoms:**
 - ✓ Incubation period is 2-3 weeks
 - ✓ Abdominal pain
 - ✓ Chest discomfort
 - ✓ Fatigue
 - ✓ Fever
 - ✓ Nausea & vomiting
 - ✓ Respiratory distress



Q Fever Chest X-Ray Comparison

- **Treatment. Several months of antibiotic treatment**
 - ✓ Treated with a combination of antibiotics including doxycycline and hydroxychloroquine for several months

Biological Warfare Agents

• **VIRUSES**

- **Smallpox**
- **Viral Hemorrhagic Fevers**
 - ✓ Ebola
 - ✓ Marburg
- **Monkeypox**

Biological Agents: Smallpox (virus)

Smallpox a serious infectious disease caused by the **variola virus**. It is **contagious**—meaning, it spread from one person to another. People who had smallpox had a fever and a distinctive, progressive skin rash. Note last major outbreak in the US was 1949.

- **Routes of Exposure:** Inhalation & Dermal Contact
- **Incubation period** is 7-17 days, with a 12-day average.
- **Mortality rate** for unvaccinated persons is 30%
- **Symptoms:**
- **Rash Stage (after 2-4 days)**
 - ✓ Oral rash, skin inflammation & lesions

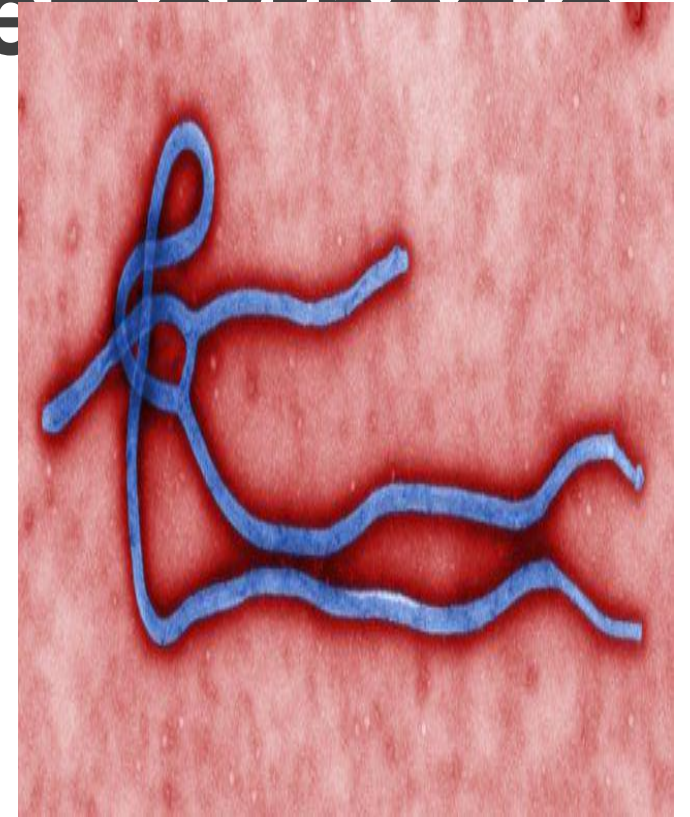
Post-incubation.

- ✓ Back pain
- ✓ Muscle rigidity
- ✓ Headache & Fever
- ✓ Nausea & Vomiting
- **Treatment. Vaccine effective if administered with 3-5 days of exposure. Once you develop the rash the vaccine will not protect you**



Biological Agents: Viral Hemorrhagic Fevers(VHF)

- **VHFs** are caused by viruses of four(4) distinct families: Arenaviridae, Bunyaviridae, Filoviridae, and Flaviviridae.
- **Routes of Exposure.** Inhalation, Eyes, & Dermal Contact.
 - Direct contact with blood & body fluids allows for person-to-person transmission
- **Incubation Period.** 2-27 days and varies with each agent.
- **Signs & Symptoms:**
 - Bleeding from body orifices
 - Diarrhea
 - Headache, nausea, vomiting & fever... and a lot more
- **Mortality rate varies with each agent. Low of 10% to as high as 90% with Ebola**
- **Examples of VHF's:**
 - Ebola
 - Marburg
 - Lassa
 - Yellow Fever



Ebola Vaccine was approved by FDA December 2019

Biological Agents: Monkeypox (virus)

- **Monkeypox is a rare disease that is caused by infection with monkeypox virus.**
- **Routes of Exposure.** The virus enters the body through broken skin (even if not visible), respiratory tract, or the mucous membranes (eyes, nose, or mouth)
- **Incubation Period** usually 7–14 days but can range from 5–21 days
- **Signs & Symptoms:**
 - Fever
 - Headache
 - Muscle aches
 - Backache
 - Swollen lymph nodes
 - Chills
 - Exhaustion
 - Within 1 to 3 days (sometimes longer) after the appearance of fever, the patient develops a rash, often beginning on the face then spreading to other parts of the body
- **Treatment. Smallpox vaccine has been effective in approx. 85%**
- **Mortality rate approximately 10%**



Biological Agents: Venezuelan Equine Encephalitis (VEE) Virus

- **Venezuelan equine encephalitis virus** is a [mosquito](#)-borne [viral](#) pathogen that causes **Venezuelan equine encephalitis** or **encephalomyelitis (VEE)**.
- **Routes of Exposure:** Inhalation, Dermal Contact or Mosquito-borne.
- **Considered very contagious**
- **Incubation Period:** The incubation period is usually about 2 to 6 days after exposure to the virus, but can be as short as 24 hours..
- **Signs & Symptoms:** flu-like symptoms such as headache, myalgia, fatigue, vomiting, nausea, sore throat, non-productive cough, pharyngitis and fever appear abruptly, 2 to 5 days after exposure to the virus. 4-14% of cases develop neurological complications, mostly in children & young adults.
- **Treatment.** There is no specific treatment for VEE. Antibiotics are not effective against viruses, and no effective anti-viral drugs have been discovered.
- **Vaccine** is available for preventative measures.
- **Mortality rate approximately 1 %**

Biological Agents: Botulism(Toxin)

- **Botulism is a rare but serious illness caused by a toxin that attacks the body's nerves.**
- **Types:** There are four(4) types; Foodborne, Wound, Infant, Adult intestinal toxemia
- **Routes of Exposure:** Inhalation, Ingestion, or Dermal Contact
- **Signs & Symptoms:** botulism typically start with paralysis of muscles in the face
 - **General:** Fatigue, Flaccid paralysis, Not feverish, Respiratory distress.
 - **Wound & Ingestion:** Difficulty swallowing, Droopy eyelids, Sensitivity to light, Muscle weakness, Respiratory paralysis leading to death
- **Treatment**
 - Antitoxin. The toxin attacks the body's nerves, and the antitoxin prevents it from causing any more harm. It does not heal the damage the toxin has already done.
 - If you have wound botulism, your doctor may need to surgically remove the source of the toxin-producing bacteria and give you antibiotics
- **Mortality rate approximately 5% with prompt medical care & treatment**

Botulism

Classification and external resources



A 14-year-old with botulism. Note the weakness of eye muscles and the **drooping eyelid** in the left image, and the large and non moving pupils in the right image. This youth was fully conscious.

Biological Agents: Ricin (Toxin)

- **Ricin is a poison found naturally in castor beans.** If castor beans are chewed and swallowed, the released ricin can cause injury. Ricin can be made from the waste material left over from processing castor beans.
 - ✓ It can be in the form of a powder, a mist, or a pellet, or it can be dissolved in water or weak acid.
 - ✓ It is a stable substance under normal conditions but can be inactivated by heat above 80 degrees centigrade (176 degrees Fahrenheit)
 - ✓ Ricin poisoning is not contagious. However, if you come into contact with someone who has ricin on their body or clothes, you could become exposed to it

Routes of Exposure, Ingestion, Inhalation, Dermal Penetration

- ✓ In 1978, Georgi Markov, a Bulgarian writer and journalist who was living in London, died after he was attacked by a man with an umbrella. The umbrella had been rigged to inject a poison ricin pellet under Markov's skin.

Signs & Symptoms. General - Flu-like, Seizures, Shock, Sweating

- ✓ Inhalations: Chest discomfort, Cyanosis, Nausea & Vomiting, Rapid Heart Rate
- ✓ Ingestion: Abdominal Pain, Bloody Diarrhea, Dehydration, Nausea & Vomiting
- ✓ Injection: Diminished Urine Production. Causes death of muscles & lymph nodes near injection site

Effects present in: 4-8 hours and as late as 24 hours

Fatal Dose: 5-6 castor beans for child & 20 beans for adult

Treatment. No antidote exists. If exposure cannot be avoided, the most important factor is then getting the ricin off or out of the body as quickly as possible.

Mortality Rate: Large dose approximately 100%

Dangerous ricin

Ricin is one of the most poisonous naturally occurring substances known.

Ricin is derived from beans of the castor oil plant, which is easily available worldwide.

Castor oil is used in food products, medicine and industry.

Ricin facts

- No vaccine available
- Very toxic to cells, damages all organs
- Can be fatal when inhaled, ingested or injected
- Per gram, it is 6,000 times more poisonous than cyanide

Symptoms

- Cough
- Weakness
- Fever
- Seizures
- Lung damage
- Heart failure
- Upset stomach

Source: eMedicine, BBC, AFP

Ricinus communis

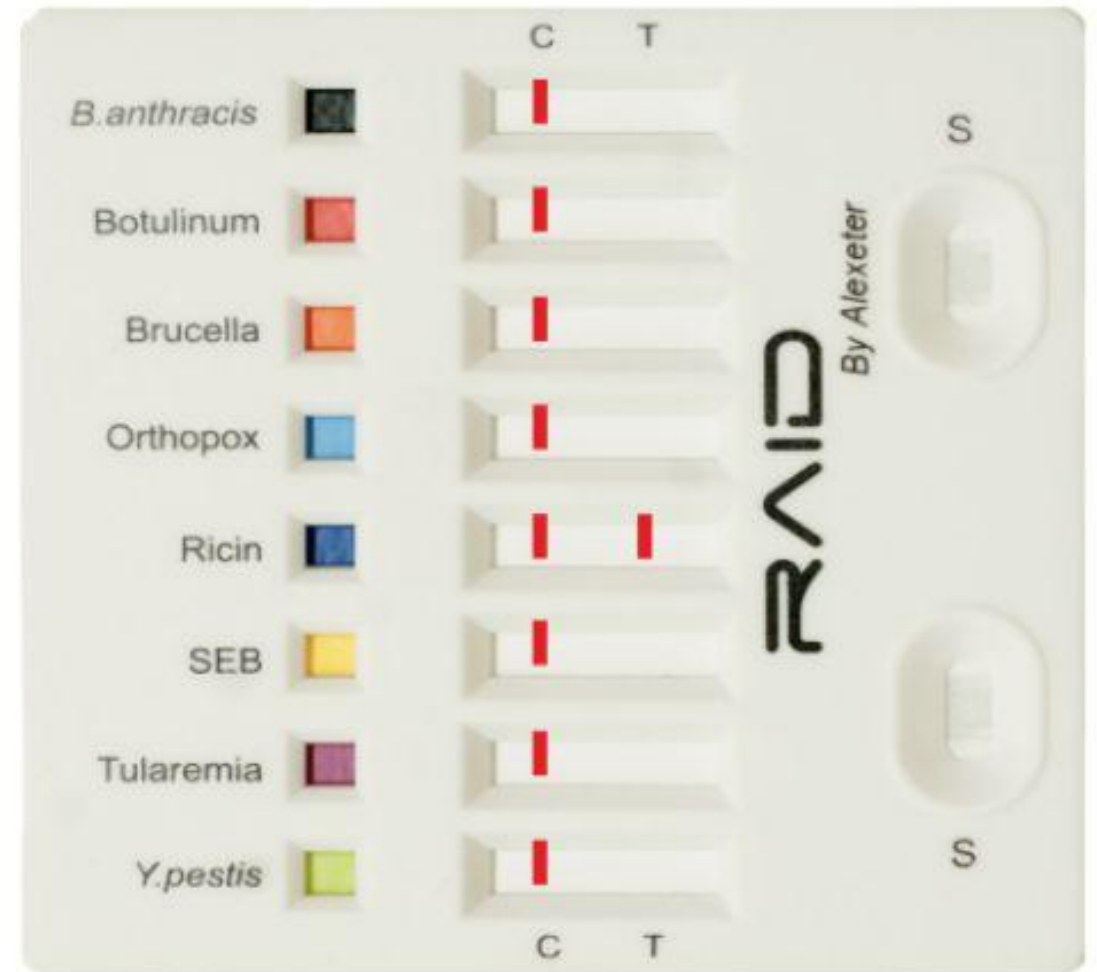
NOTE: Beans and plant are not to scale



McClatchy Tribune

GC HazMat Biological Detection Capabilities

- Alexeter RAID 8 Bio Threat Detection Kit
- Storage room temperature
 - 59 F to – 22 F
- Shelf Life – printed on package
- SEB- Staphylococcal Entertoxin B



Example of positive results for Ricin

Biological Warfare Agents

Questions & Review

Radiological Learning Objectives

- List & explain key terms germane to radiological material
- Explain the four(4) types of radiation and their potential harm
- List & describe the potential sources of radiation
- List & identify radiation detection systems.
- List & Explain basic First Responder safety protocols

- **References:**

- NFPA 470-2022 ed.
- FEMA NIMS 2017
- US HHS Radiation Emergency Medical Management (REMM)
- USDOE Transportation Emergency Preparedness Program (TEPP)



Radiological Key Terms

- **Ionizing radiation:** any radiation capable of displacing [electrons](#) from [atoms](#), thereby producing [ions](#). High doses of ionizing radiation may produce severe skin or tissue damage.
- **Irradiation:** exposure to radiation
- **Radiation vs. Contamination.** Radiation is energy emitted by radioactive material. Contamination is radioactive material in a location where it is NOT wanted
- **Radioactivity:** the process of spontaneous transformation of the [nucleus](#), generally with the emission of [alpha](#) or [beta particles](#) often accompanied by [gamma rays](#). This process is referred to as [decay](#) or disintegration of an atom.
- **Half-life:** the time any substance takes to decay by half of its original amount. See *also* [biological half-life](#), [decay constant](#), [effective half-life](#), [radioactive half-life](#).
- **Dose (radiation):** radiation absorbed by a person's body. Several different terms describe radiation dose. For more information, see "[Primer on Radiation Measurement](#)" from CDC.

Radiological Key Terms - continued

- **Dose rate:** the [radiation dose](#) delivered per unit of time.
- **Radiological dispersal device (RDD):** a device that disperses [radioactive material](#) by conventional explosive or other mechanical means, such as a spray. *See also* [dirty bomb](#).
- **Improvised Nuclear Devices (INDs)** An illicit nuclear weapon bought, stolen, or otherwise originating from a nuclear state, or a weapon fabricated by a terrorist group from illegally obtained fissile nuclear weapons material that produces a nuclear explosion. National planning scenarios is based on a 10 KT detonation.
- **RAD. Radiation Absorbed Dose**
- **REM : Roentgen Equivalent Man**
- **Radiological exposure device (RED):** also called a "hidden sealed source"
 - An RED is a terrorist device intended to [expose](#) people to significant doses of ionizing radiation without their knowledge

Potential Sources of Radiation

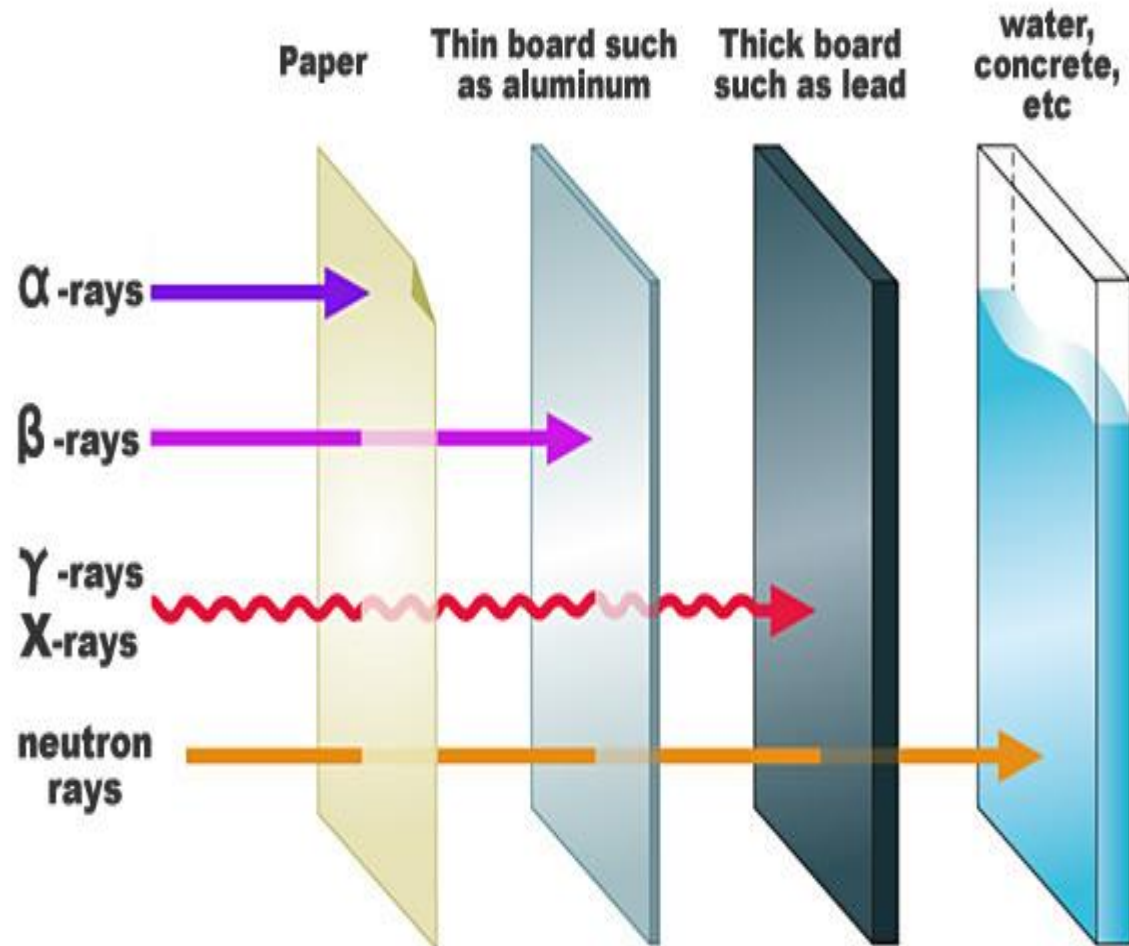
- Naturally occurring
- Manmade
- Medical facilities
- Research Laboratories
- Nuclear Power Plants
- Industrial/Commercial facilities
- Government/Military facilities
- Radiological material/waste shipments
- Industrial applications



Four(4) Types of Ionizing Radiation

- **Alpha**
 - 2 protons, 2 neutrons = +2
 - Internal Hazard
- **Beta**
 - 1 electron = -1
 - Internal/External hazard
- **Gamma**
 - Pure energy photons = no charge
 - Whole body hazard
- **Neutron**
 - Neutron = no charge
 - Whole body hazard

Radiation types and the degree of penetration



Units of Radiation Dose and Exposure

Roentgen (R)	Rad (Radiation Absorbed Dose)	Rem (Roentgen Equivalent Man)
Unit for measuring exposure	Unit for measuring absorbed dose in any material	Unit for measuring dose equivalence
Defined only for the effect on air	Defined for any material	Pertains to the human body
Applies only to gamma and x-ray radiation	Applies to all types of radiation	Applies to all types of radiation
Does not relate biological effects of radiation to the human body	Does not take into account the potential effect that different types of radiation have on the human body	Takes into account the dose and the biological effect on the human body due to different types of radiation

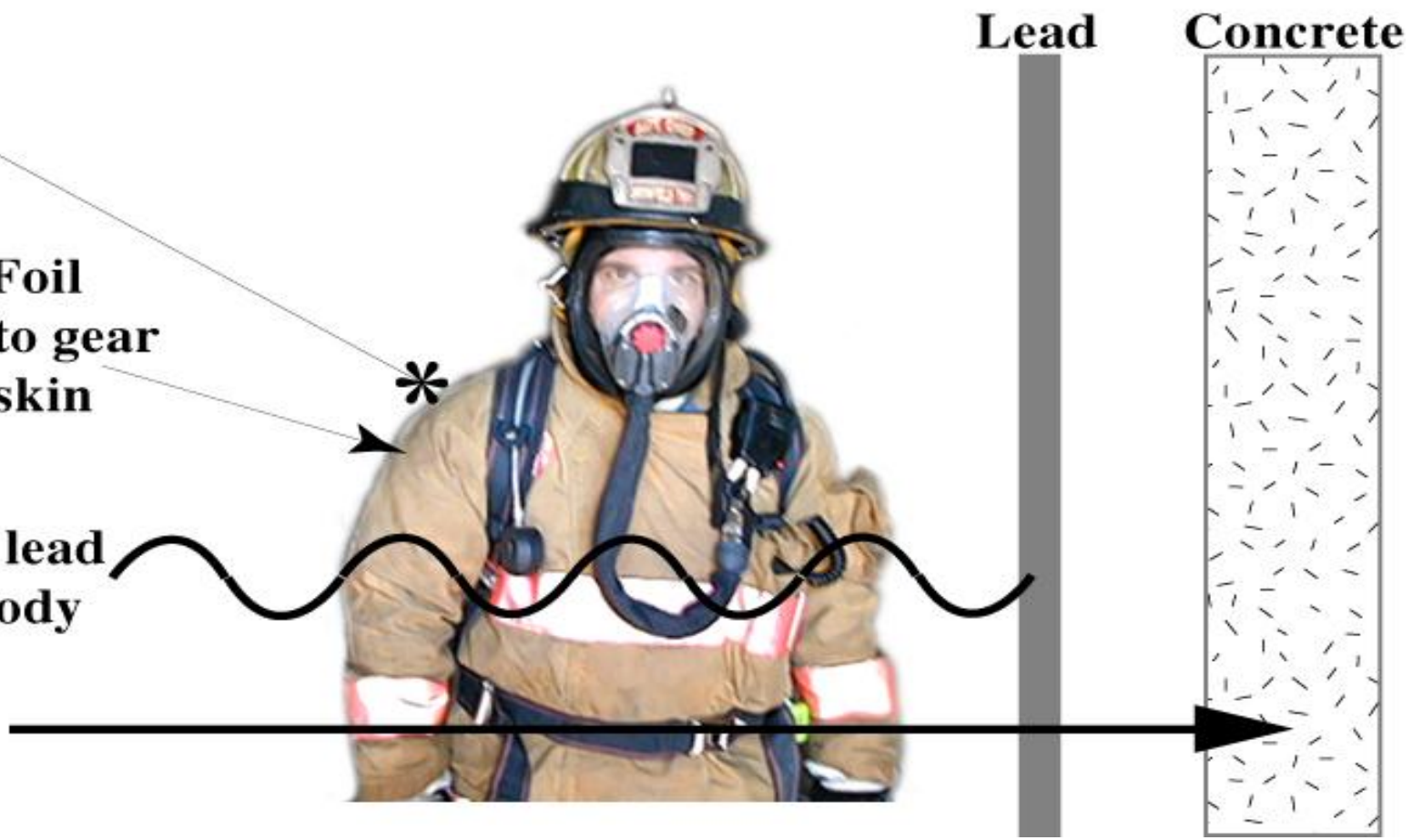
Penetrating Power

ALPHA Particle
Stopped by paper or
Outer Turnout gear

BETA Particle
Stopped by Aluminum Foil
May penetrate partially into gear
May penetrate exposed skin

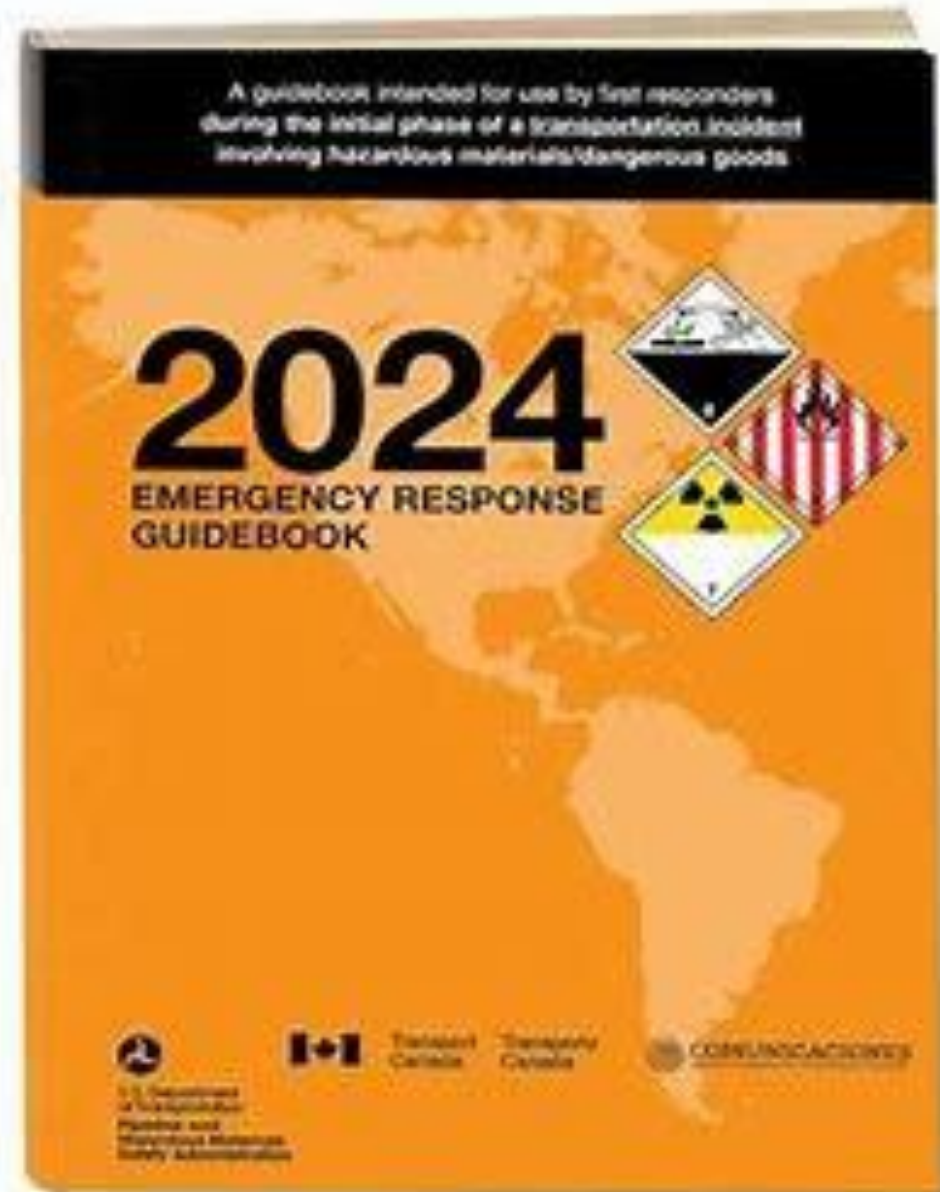
GAMMA "Ray"
Stopped by a few inches of lead
Will penetrate gear and body

NEUTRON Particle



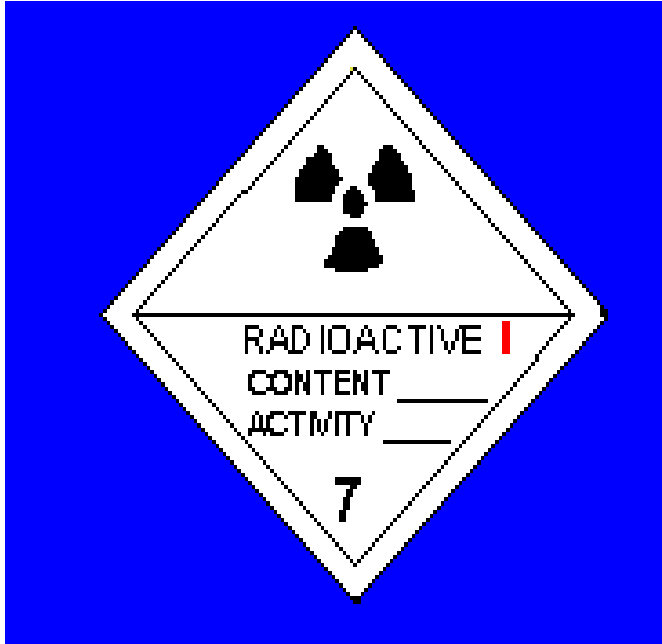
US DOT ERG

- Use guides 161 – 166
- Only substance in ERG that SFPC with SCBA can provide adequate protection



Minimal levels

USDOT Class 7 Label & Placarding



Medium levels



Highest levels



Radioactive Materials Shipping Packages

- Excepted Packaging
- Industrial
- Type A
- Type B
- Type C (Air Transport)



Radioactive Materials Containers

Excepted Packaging

- Medical materials, extremely Low Level
- Medical diagnostic instruments
- Smoke detectors



Radioactive Materials Containers

Type A Packaging

- Radiological pharmaceuticals
- Regulatory qualified industrial products



First Responder Protective Actions

TIME:

- Limit the time you spend near the source
- The shorter the time in a radiation field, the less the radiation exposure
- Work quickly and efficiently
- Rotating team approach can be used to keep individual radiation exposure to a minimum



First Responder Protective Actions

DISTANCE:

- Increase the distance between yourself and the source
- The farther a person is from the source of radiation, the lower the dose
- Doubling the distance will quarter the dose of radiation (***Inverse Square Law***)
- Do not touch radioactive materials, use shovels, brooms etc., to move materials

First Responder Protective Actions

SHIELDING:

- Although not always practical in emergency situations, shielding offered by barriers can reduce radiation exposure
- Alpha cannot penetrate unbroken skin or paper
- Beta is stopped by aluminum foil or clothing
- Gamma rays require dense materials such as lead, earth, concrete, or steel

Nuclear Key Terms



Blast forces/waves: shock waves causing mechanical damage.

Direct blast wave pulse overpressure forces (measured in atmospheres of pressure) propagate out from blast

Indirect blast wind drag forces (measured in wind velocity)



Prompt radiation dose.

Radiation levels are greatest near the epicenter of the explosion, and decrease rapidly with distance from the point of the burst.

Carried predominantly by [gamma rays](#) and [neutrons](#) produced within the first minutes after the explosion

Can cause [whole body exposure](#) and [Acute Radiation Syndrome](#), if dose is sufficient



Fallout. After and IND, radioactive material that returns to the ground after it is propelled into the atmosphere is called "**fallout**"



Fallout & ground shine Low-level winds do not predict the direction of fallout.

These radioactive clouds have been called the "**plume**", and the radiation emitted from these "plumes" has been called "**cloud shine**"

Nuclear Detonation

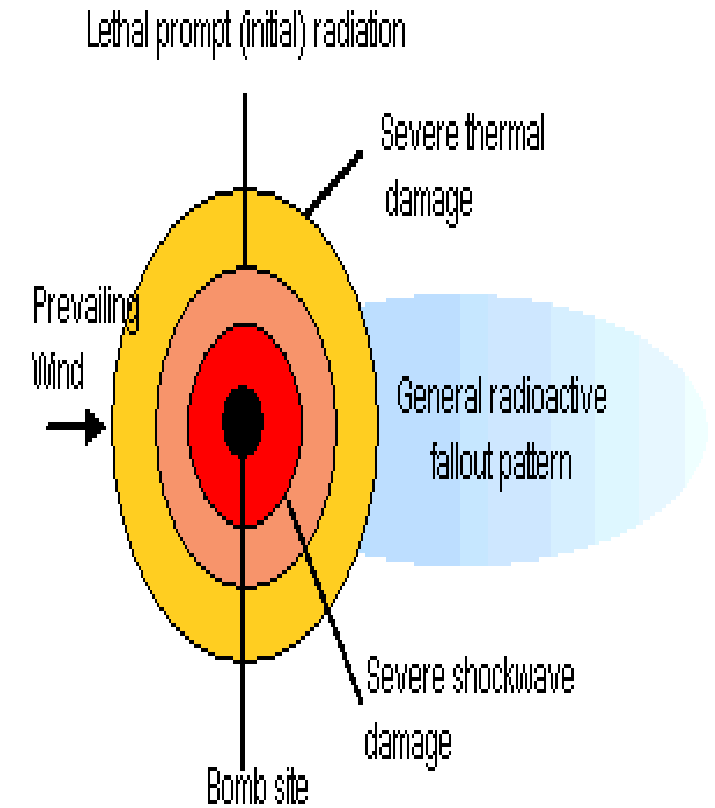


<10 KT Explosion:

- The Severe Damage Zone will extend to ~ 1/2 mile (0.8 km)
- The Moderate Damage Zone will be from ~ 1/2 mile (0.8 km) to ~ 1 mile (1.6 km)
- The Light Damage Zone will extend from ~ 1 mile (1.6 km) to ~3 miles (4.8 km)

1 KT Explosion:

- The Severe Damage Zone will extend to ~ 1/4 mile (0.4 km)
- The Moderate Damage Zone will be from ~ 1/4 mile (0.4 km) to ~ 1/2 mile (0.8 km)
- The Light Damage Zone will extend from ~ 1/2 (0.8 km) mile to ~2 miles (3.2 km)



GC HazMat Radiation Detection

- iDentifier R 400 ??
- GammaRAE IIR ??
- Ludlum ??
- ??

CBRNE(WMD) Review

- **C- Chemical Agents**
 - Chemical Warfare & Toxic Industrial Chemicals.
- **B – Biological Agents**
 - Bacterial, Virus, & Toxins
- **R – Radiological.**
 - Exposure to Radiation through a Radiological Dispersion Device- aka Dirty Bomb
- **N - Nuclear.**
 - Exposure to potential High Levels of Radiation from a nuclear detonation.
- **“E” Explosives.** The US Military still uses the term CBRNE