CHEMICAL, BIOLOGICAL, RADIOLOGICAL, AND NUCLEAR (CBRN) IN VBSS TRAINING

UNODC
Global Maritime Crime Programme

HANDBOOK

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CHEMICAL AGENTS & WEAPONS

CBRN

- **C for Chemical**
- **B for Biological**
- **R for Radiological**
- **N for Nuclear**

CHEMICAL WEAPONS

- A chemical weapon is any toxic chemical that can cause death, injury, incapacitation, or damage to senses
- Deployed via a delivery system, such as an artillery shell, rocket, or ballistic missile.
- Exists in three states: Solid, Liquid, and Gas.

TOXIN

- A toxin is a poisonous substance produced within living cells or organisms.
- Because toxins are chemicals produced by biological organisms, they can be considered chemical or biological weapons
- As modern chemistry can synthesize an ever- growing number of toxins, they fall under the purview of the CWC.
- Two toxins, Ricin and Saxitoxin, are listed on Schedule 1 of the CWC.

Toxins	Chemical Agents
Natural Occuring	Artifically Produced
Difficult Small Scale Production	Large Scale Industrial Production
Many are more toxic	Less toxic than many toxins
Legitimate Medical Use	Almost no medical uses
Odorless and tasteless	Noticeable Odor or Taste
Diverse Toxic Effects	Fewer types of Effects
Aersol Delivery	Mist/Droplet/Aerosol Delivery

WHAT ARE CHEMICAL WEAPONS?

Toxic chemicals are defined as 'any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals'.

Any device specifically designed to inflict harm or cause death through the release of toxic chemicals. Among these could be mortars, artillery shells, missiles, bombs, mines or spray tanks.

Any equipment specifically designed for use 'directly in connection' with the employment of munitions and devices identified as chemical weapons.

EXAMPLES OF CWS INCLUDE, BUT ARE NOT LIMITED TO:

- Fully developed chemical weapons and the components of such weapons when stored separately (e.g. binary munitions).
- Chemicals used to produce chemical weapons (precursors).
- Chemicals used to cause intentional death or harm.
- Items with peaceful civilian uses, when used or intended for chemical weapons use (dual-use items).
- Munitions and devices intended for the delivery of toxic chemicals.
- Equipment directly in connection with aforementioned munitions and devices.

WHAT ARE THE POSSIBLE INDICATORS OF A CHEMICAL WEAPON ATTACK?

- All chemicals act differently and there are no common indicators for all chemical agents.
- In some cases there may be no immediate and obvious indicators of a chemical weapons attack.
- Some chemical agents can produce obvious visual signs of exposure in groups of persons, including:
    - Eye irritation, visual changes, vomiting and diarrhoea;
    - Coughing, breathing difficulties and respiratory irregularities;
    - Muscle weakness, paralysis and seizures;
    - Skin redness, irritation and burns; and
    - Collapse, loss of consciousness, or death.

HISTORY – USE OF CHEMICAL WEAPONS

In World War I, Germany released chlorine gas from pressurized cylinders in April 1915 at Ypres, Belgium. 600 deaths.

With the introduction of mustard gases in 1917, chemical weapons injured more than a million soldiers and killed 100,000 during the 1914-1918 war.

Iraq used chemical weapons in the 1980-1988 Iran-Iraq war and against the Kurds in Halabja in 1988.

Aum Shinrikyo: The Japanese cult behind the Tokyo Sarin attack in 1995
5 coordinated attacks
13 people killed and 5800 died

In February 2017, VX, a nerve agent, was used to assassinate Kim Jong-nam, the half-brother of North Korean leader Kim Jong-un in the airport in Kuala Lumpur, Malaysia.

In March 2018, a Novichok was used to assassinate a former Russian spy, Sergei Skripal, and his daughter, Yulia, in the UK.

INTERNATIONAL CONVENTIONS

- 1925 Geneva Convention: Protocol on the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare
- CWC- Chemical Weapons Convention: Bans the production, stockpiling, transferring, and use of chemical weapons.
- OPCW :Implementing body of the CWC.

CWC SCHEDULES AND PARTS

SCHEDULE 1

- Have few or no uses other as CW or to make CWs
- Examples include the nerve agents, sulfur mustards, nitrogen mustards, and lewisite

SCHEDULE 2

- Could be used as weapons or to make weapons, but also have legitimate small scale uses
- Examples include Amiton (aV-seriesnerve agent) and BZ (Benzalite).

SCHEDULE 3

- Could be used as weapons or to make weapons, but also have large scale uses other than CW such as Chlorine

CWC EFFECTS

1, Each State Party to this Convention undertakes never under any circumstances:

(a) To develop, produce, otherwise acquire, stockpile or retain chemical weapons, or transfer, directly or indirectly, chemical weapons to anyone;

(b) To use chemical weapons;

(c) To engage in any military preparations to use chemical weapons;

(d) To assist, encourage or induce, in any way, anyone to engage in any activity prohibited to a State Party under this Convention.

2. Each State Party undertakes to destroy chemical weapons it owns or possesses, or that are located in any place under its jurisdiction or control, in accordance with the provisions of this Convention.

3. Each State Party undertakes to destroy all chemical weapons it abandoned on the territory of another State Party, in accordance with the provisions of this Convention.

4. Each State Party undertakes to destroy any chemical weapons production facilities it owns or possesses, or that are located in any place under its jurisdiction or control, in accordance with the provisions of this Convention.

5. Each State Party undertakes not to use riot control agents as a method of warfare.

TYPES OF CHEMICAL AGENTS

- CHOKING AGENTS
- BLISTER AGENTS
- BLOOD AGENTS
- NERVE AGENTS
- RIOT CONTROL AGENTS

CHOKING AGENTS

- Inflicting injury mainly on the respiratory tract, choking agents irritate the nose, throat, and especially the lungs. When inhaled, these agents cause alveoli, air sacs in the lungs, to secrete fluid, essentially drowning those affected
- Example agents: Chlorine (Cl), Chloropicrin (PS), Diphosgene (DP), Phosgene (CG)
- Dispersal: Gas
- Mode of Action: Absorption through lungs
- Effects: Fluid builds up in lungs, choking victim
- Required defensive gear: protective masks
- A small-scale malicious chemical program can easily be hidden behind a normal industrial/research chemistry front.
- Chlorine is used for water purification and to make many other compounds.
- Phosgene issued to make important compounds, including pharmaceuticals and plastics.

PHOSGENE

- Gas above 8.2˚C, so it is easy to disperse.
- Less irritating than Chlorine, so not easy to realize that there is a chemical agent in the air
- Smells like new-mown hay (khara in Bengali and Vaikkōl in Tamil) 18 times more toxic than Chlorine
- It causes suffocation by reacting with proteins and disrupting the transfer of oxygen to the body.
- More difficult to make than chlorine

BLISTERING AGENTS

- Exposure to blister agents cause large and often life-threatening skin blisters which resemble severe burns, and often results in blindness and permanent damage to the respiratory system.
- Example Agents: Sulfur mustard (H, HD), nitrogen mustard (HN), lewisite (L) and phosgene oxime (CX)
- Dispersal: Liquid, aerosol, vapour, and dust
- Mode of Action: Inhalation, skin
- Effects: Burns skin, mucous membranes and eyes; blisters skin, windpipe, and lungs
- Required defensive gear: protective mask and clothing
- Thiodiglycol (CWC Schedule 2 Part B)
- Used to make many things, including pen inks, plastics, pesticides, dyes, and photographic developing solutions. Produced in several countries, including Germany and the UK.
- Many firms purchase it.
- If thiodiglycol can be obtained, making sulfur mustard is not difficult.
- It does not require sophisticated equipment.

SULFUR MUSTARD

- 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.
- It is relatively easy to make.
- It can remain on the ground for weeks, making the area dangerous long after its dispersal.

PHYSICAL PROPERTIES OF SULFUR MUSTARD GAS

- Can remain in environment for up to a week (but much longer if buried beneath soil surface)
- Pale yellow or amber color
- Usually odorless but can smell like mustard, onions, or garlic
- Heavier than air

SULFUR MUSTARD TREATMENT

- Can limit the formation of blisters by applying household bleach or a solution called DS2 (Decontamination Solution)
- 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 less likely that the treatments would be done in time to avoid problems.
- Fatal in about 2% of exposures, so mostly used as an incapacitating agent.

BLOOD AGENTS

- These agents mainly inhibit the ability of cells to use oxygen, effectively causing the body to suffocate. Some blood agents may also affect the ability of blood cells to transfer oxygen. Blood agents are distributed via the blood and generally enter the body through inhalation.
- Example agents: Hydrogen cyanide (AC), Cyanogen chloride (CK), Arsine (SA)
- Dispersal: Gas
- Mode of Action: Absorption through lungs and skin;
- Effects: Cells' ability to use oxygen is impaired, leading to damage to vital organs including those of the nervous system, heart and respiratory system
- Required defensive gear: protective masks

BLOOD AGENTS: HYDROGEN CYANIDE

- Used in industry to make many important chemicals
- Fatal at concentrations as low as 300 mg/m3 in air.
- According to OPCW, there are no confirmed uses as CW, but may have been used by U.S., France, and Italy in WWI and by Iraq against Iran and the Kurds.
- Unlike chlorine and phosgene, it's less dense than air, so it disperses too quickly to be effective outside.

NERVE AGENTS

- Nerve agents lead to hyper-stimulation of muscles, glands and other nerves. Nerve agents are highly toxic with rapid effects. They act primarily by absorption through the skin and lungs.
- Nerve agents are divided into two main groups: G-series agents and V-series agents, named for their military designations.
- Some G-agents, particularly Tabun and Sarin, persist in the environment for only short periods.
- V-agents are extremely potent, with only milligrams needed to cause death, and persist for long periods of time in the environment.
- Example agents: Tabun (GA), Sarin (GB), Soman (GD), Cyclosarin (GF), VX
- Dispersal: Liquid, aerosol, vapour and dust
- Mode of Action: Absorption through lungs, contact with skin
- Effects: Sweating, blurred vision, headache, difficulty in breathing and vomiting.
- In higher doses, nerve agents cause seizures, loss of body control, muscle paralysis and unconsciousness.
- Required defensive gear: Protected masks and clothing.

PHYSICAL PROPERTIES OF VX

- Three times 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 spray.
- Clings to whatever it hits.
- When sprayed on the ground, remains lethal for up to three weeks, so it is an area denial weapon.

PHYSICAL PROPERTIES OF SARIN

- A lethal dose (1,700 mg) of Sarin, absorbed through the skin, can kill within 5-10 minutes
- Evaporates quickly
- Odorless/tasteless/colorless
- Absorbed slowly through skin
- Spread in aerosol or liquid form
- Heavier than air
- Hard to make

DUAL USE OF CHEMICALS

- Most precursors have legitimate commercial uses.
- Dual-use nature impedes detection of CW programs.
- Trade in precursors is monitored and controlled.

Chemical Compound	**Commercial Uses**	**CW Agent**
Thiodiglycol	Plastics, textile dyes, ink	Mustard Agent
Phosphorus trichloride	Plasticizers, insecticides	Sarin
Sodium cyanide	Dyes & pigments, nylon, metal hardening	HCN
Methylphosphonic difluoride	Organic synthesis	Sarin, VX
Phosphorus pentasulfide	Insecticides, lubricants, pyrotechnics	VX

DETECTION TECHNIQUE

- Collection of evidence via
  - Environmental samples and Biomedical samples
  - Interviews
  - Photos, video
  - On-site detectors
  - On-site analysis
  - OPCW designated laboratory network
- Environmental samples
  - Residue from a reaction or waste container
  - Contaminated clothing, hair, soil, water, etc.
  - Survey analysis is possible
- Biomedical samples
  - Urine, blood, plasma, tissue, etc.

DETECTION EQUIPMENT

- Laser driven Raman Spectroscopy
  - Analysis through glass
  - No sample prep
  - Fast analysis
  - Portable
  - Easy use
- Cons:
  - Not as sensitive as GC/MS
  - Works best with pure chemicals

DETECTION TECHNIQUE

- Attenuated total reflectance fourier transform infrared spectroscopy (ATR FT- IR)
  - No sample prep
  - Fast analysis
  - Portable
  - Easy use
- Cons
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  - Works best with pure chemicals

DETECTION TECHNIQUE

- Attenuated total reflectance fourier transform infrared spectroscopy (ATR FT- IR)

- Pros
  - No sample prep
  - Fast analysis
  - Portable
  - Easy use

- Cons
  - Not as sensitive as
  - GC/MS
  - Works best with pure chemicals

DETECTION TECHNIQUE

- Minimal Sample prep Relatively fast analysis
  - Portable
  - Easy use

- Cons:
  - Not as “full-range” as research grade GC/MS
  - Battery change every 3 hours

SUMMARY

	Nerve Agents		Blister Agents	Blood Agents	Choking Agents	
EXAMPLES	Sarin	VX	Mustard	Hydrogen Cyanide	Chlorine	Phosgene
ODOR	Odorless		Garlic	Burnt Almonds	Bleach	Mown hay
RATE OF ACTIONS	Rapid for vapors		Delayed	Rapid	Rapid at high conc. Delayed at lower conc.	
SIGNS AND SYMPTOMS	Headache, runny nose, salivation, pinpointing of pupils, difficulty in breathing, tight chest, seizures, convulsions, nausea, and vomiting		Red, burning skin, blisters,sore throat, dry cough; eye damage, nausea, vomiting, diarrhea. Symptoms may be delayed 2 to 24 hrs	Cherry red skin/ lips, rapid breathing, dizziness, nausea, vomiting, dilated pupils, excessive salivation, respiratory arrest	Eye and airway irritation, dizziness, tightness in chest, pulmonary edema, painful cough, nausea, headache	
FIRST AID	Remove from area,treat symptomatically, Atropine and pralidoxime chloride (2-PAM chloride), diazepam for seizure control		Decontaminate with copious amount of water, remove clothing, support airway, treat symptomatically	Remove from area, assist ventilations, treat symptomatically, administer cyanide kit	Remove from area, remove contaminated clothing, assist ventilations, rest	
DECONTAMINATION	Remove from area, remove clothing, flush with soap and water, aerate					

BIOLOGICAL AGENTS & WEAPONS

WHAT ARE BIOLOGICAL AGENTS?

- Deliberate use of pathogens or toxins against humans, livestock, or crops for military purposes

- Pathogen = infectious microorganism

    - Virus
    - Bacteria
    - Prion
    - Fungus
    - Protozoan

- Toxin = organically produced poison

WHAT ARE POTENTIAL BW TARGETS?

- HUMAN BEINGS
    - Anthrax
    - Plague
    - Smallpox
    - Botulinum toxin
- LIVESTOCK
    - Foot and mouth disease
    - Glanders
- CROPS
    - Rice blast fungus

WHAT CONSEQUENCES ARE POSSIBLE?

- Effects of different agents vary widely
  - Can kill, cause physical degradation, incapacitate, kill

- Effectiveness of bio weapon depends on many factors
  - How delivered, size of aerosolized particles, weather conditions (sun, wind, moisture)

- Defenses possible, but effectiveness variable
  - For some diseases, can vaccinate ahead of time
  - For some, treat after exposure if know attack happened
  - Consequence management crucial

GREAT UNCERTAINTY IN THREAT ASSESSMENT

- Of all "WMD," BW threat is hardest to estimate

- Easy to keep covert, so hard to assess who has programs

- Range of estimated impacts run full spectrum
  - 50kg of anthrax in city could kill about 1,000,000 people
  - Many actual attempted attacks kill no one

- Some defensive measures possible

- Impact of future genetic engineering and biotech efforts hard to forecast

DIFFERENCE BETWEEN CW AND BW

- CW are human made, cause physiological effects

- BW come from living microorganisms

  - That produce sickness (infection) or produce toxins (poisons); they comprise pathogens & toxins
  - Pathogens = living organisms that produce disease
  - Toxins = non-living chemical poisons produced by living organisms (bacteria, fungi, algae, plants, animals)
  - Wide variety of pathogens and toxins could potentially be used in warfare or terrorism

DIFFERENCE BETWEEN CW AND BW

- Bacterial (single-cell organisms): e.g. anthrax
  - Some, like anthrax, also come in spore form (dormant form of bacteria, somewhat like a seed is for a plant)

- Rickettsial (parasitic microorganisms, live inside cells): e.g. typhus, Q fever
  - Like bacteria, can often be treated with antibiotics

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- Viral (subcellular invaders, much smaller than bacteria, can only replicate inside living cells): e.g. smallpox
  - NOT treatable with antibiotics

- Toxin (naturally occurring poisons): e.g. ricin, botulinum
  - Among most potent poisons in existence

RANKING THE DANGERS

- Infectious vs. Contagious
  - Infectious: measure of how much or little needed to make one individual sick
  - Contagious: can be spread from person to person

- Categories A, B, and C
  - A = easily disseminated or highly contagious + hi mortality
  - Anthrax, plague, smallpox, Ebola, botulism
  - B = moderate danger
  - C = emerging, potential future threat

ROUTES OF INFECTION

- In general, BW agents are most effective when inhaled as an aerosol

- Ingestion through covert food or water contamination is also a potential threat (in most cases food better than water)

- Entry through open wounds & abrasions is possible

BW AGENT CHARACTERISTICS

Type	Agent	Untreated Effect	Epidemic Potential
Bacteria	Anthrax	Lethal	Negligible
	Tularemia	Incapacitant-lethal	Negligible
	Plague	Lethal	High
	Cholera	Incapacitant-lethal	High
	Glanders	Lethal	Negligible
	Clostridium Perfringens	Incapacitant	Negligible
	Brucellosis	Incapacitant	Negligible
	Shigellosis	Incapacitant	Possible
Rickettsial	Q Fever	Incapacitant	Possible
	Typhus	Lethal	Negligible
Viruses	Venezuelan Equine En-cephalitis	Incapacitant-lethal	Possible
	Smallpox	Lethal	High
	Marburg/Ebola	Lethal	Possible

ANTHRAX

- Extremely infectious and virulent
  - Deadly in concentrations
  - 75 percent mortality even with treatment (inhalational)
  - Vaccines available if administered months before exposure
  - Post-infection treatment with antibiotics, must be administered before acute symptoms apparent
  - Not contagious from one individual to another

- Extremely robust
  - Can be incubated
  - Especially well suited to missile or bomb delivery
  - Cleaning up contaminated area very costly

- Relatively easy to produce
  - Obtain virulent strain from soil, animal, human, or culture bank
  - Cultivate in fermenter
  - Purify, dry, mill, coat, disseminate

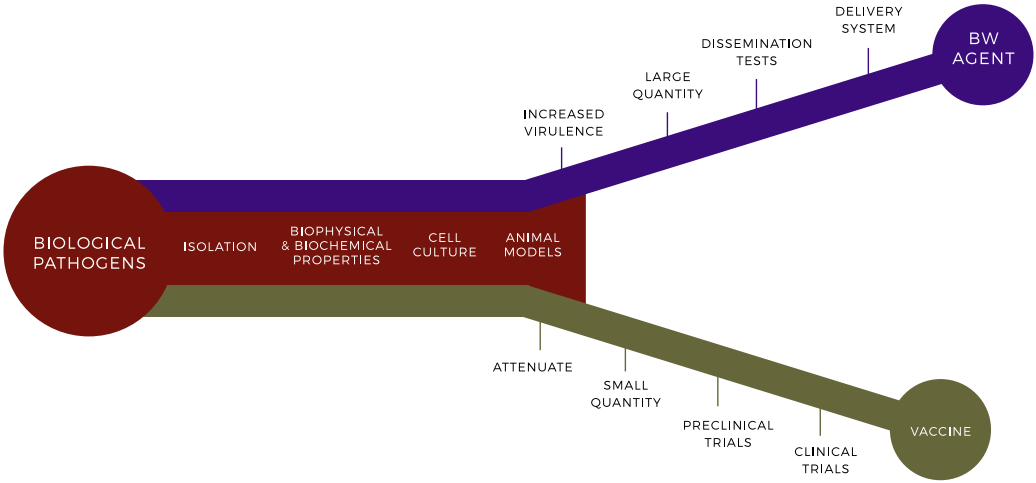
SMALLPOX

- Variola major virus causes smallpox disease

- Very contagious, relatively virulent
  - Spread via droplets, contaminated surfaces (fomites), direct contact
  - Effective vaccine exists, but no good treatment if infected (it's a virus!)
  - Eradicated 1979, as a result no longer widespread vaccination

DUAL-USE PROBLEM: BW

- Virtually all equipment, technology & materials for BW agent production are dual-use.
  - Little apparent distinction between vaccine or pharmaceutical plant from BW production facility.
  - BW production requires knowledge derived from legitimate research.



THE DUAL-USE DILEMMA

- No specialized facilities required for BW production
- Compared with CW, no specialized starting materials
- All essential production technology and know-how is dual-use
- This makes verification of BTWC very difficult and controversial
- Difference between offensive and defensive program may only be intent

CONCLUSIONS

- Potential for use of BW as WMD remains high
- Dual-use dilemma makes international control of BW very difficult
- Single hardest threat to predict
  - Hard to find programs
  - Scale of harm can vary from minimal to catastrophic
  - Intent, both state and non-state, hard to gauge
- Continued advances in biotechnology and potential for use by terrorists create growing urgency for BW control

RADIOLOGICAL AND NUCLEAR MATERIALS AND WEAPONS

BASICS OF RADIATION

- Radiation is energy emitted from atoms in the form of particles and/or waves.
- There may be many isotopes of a given element
- Radioactive decay is a process by which unstable isotopes emit energy (or radiation) in the form of particles and/or waves.
- Uranium-235 (U-235) and Uranium-238 (U-238) are both isotopes of uranium.

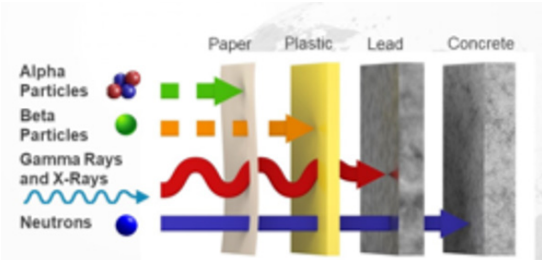
Hazard Symbol of Radioactivity

TYPES OF RADIATION

- **ALPHA PARTICLE**
- **BETA PARTICLE**
- **GAMMA RAYS AND X – RAYS**
- **NEUTRON**

Front line officers (FLOs) use gamma and neutron radiation detection instruments because these instruments can be used for nonintrusive passive inspection of conveyances, objects, or persons.

SHIELDING AND RADIATION DETECTION



RADIOACTIVE MATERIAL

- Radioactive material is broadly defined as any material that emits radiation

RADIATION EXPOSURE VS RADIATION CONTAMINATION

- Radiation exposure results from radiation interacting with the body.
- Radiation exposure does not mean you become radioactive.
- Once a source of radiation is turned off or is no longer close to a person, the exposure ends. Similarly, shielding may be used to reduce or block exposure.
- Contamination is radioactive substances on surfaces, or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable, or the process giving rise to their presence in such places.
- Contamination can be spread by touching contaminated surfaces in an area and then touching a surface in a different area.

NATURALLY OCCURRING RADIATION MATERIALS (NORM)

- Contains naturally occuring radioactive isotopes
- Typically emits gamma radiation
- Examples: rocks, soil, some food, fertalizer and ceramics
- Common naturally occurring radioactive isotopes found in NORM include:
  - Thorium-232 (Th-232)
  - Potassium-40 (K-40)
  - Radium-226 (Ra-226)
  - U-238
- Large shipments of NORM (such as slate, fertilizer, or ceramics) emit easily detectable amounts of radiation.

COMMON NORM

- Construction Materials
- Food and plants
- Rocks, minerals and Ores
- Ceramics and Glass
- House hold Items
- Industrial Equipment

RADIOACTIVE SOURCES

- Radioactive material that is permanently sealed in a capsule or bonded in a solid form
- Applications:
  - Medical – cancer therapy and blood irradiation
  - Non-medical irradiation of products – sterilization and food preservation
  - Gauging systems – material thickness, material density, and fluid level
  - Imaging systems – radiography of welds and other materials
  - Materials analysis – moisture gauge
  - Miscellaneous uses – smoke detectors, lightning rods, and self-luminous signs

- Common sealed radioactive sources for other non-medical uses include the following Gamma sources:
  - Cs-137 – calibration source, radiography, gauges, and well logging
  - Co-60 – radiography, sterilization, gauges, and lightning rods
  - Ir-192 – radiography
  - Ra-226 – gauges, some smoke detectors, and lightning rods

NUCLEAR MATERIAL

- Any source material or special fissionable material
  - Source material:
  - Natural uranium
  - Depleted Uranium
  - Thorium
- Special Fissionable Material:
  - Pu – 239
  - U – 233
  - Uranium enriched in U-233 or U -235

SIGNIFICANT QUANTITIES OF NUCLEAR MATERIAL

The significant quantity is the minimum fissionable quantity that, if diverted from peaceful use, could be used directly (without further enrichment or chemical separation) to manufacture a nuclear explosive device.

Nuclear Material	**Significant Quantity**
PLUTONIUM (PU 230 > 95 %)	8 kgs
(U – 238 MORE THAN 20 %)	25 kgs
U - 233	8 kgs

INTERNATIONAL CONVENTIONS AND REGULATIONS

- Non – Proliferation Treaty (Classified the world into Nuclear Weapon States and Non – Nuclear Weapon States)
- International Atomic Energy Agency in Vienna, Austria
- United Nations Security Council Resolutions 1373 and 1540

REGULATORY CONTROL AND MATERIAL OUT OF REGULATORY CONTROL

- **Regulatory Control:** Institutional control applied to nuclear material or other radioactive material, associated facilities, or associated activities by any competent authority as required by the legislative and regulatory provisions

- Examples of controls may include:
  - Authorized users, applications, and facilities
  - Transport, handling, and storage requirements
  - Quantity restrictions

- **Material out of Regulatory Control (MORC)**: The absence of the direct control over nuclear or other radioactive material by an authorized person that is or would be mandated by regulatory control for such material.

WEAPONIZATION OF NUCLEAR AND RADIOLOGICAL MATERIAL

- Radiation Explosive Device (RED)
- Radiation Dispersion Device (RDD)
- Improvised Nuclear Device (IND)

RADIATION DISPERSAL DEVICE

- A device to spread radioactive material using conventional explosives or other means
- Does NOT produce a nuclear explosion
- Creates fear and panic, contaminate areas, and negatively affect the economy.'

RADIATION DISPERSAL DEVICE

- "A device with radioactive material designed to intentionally expose members of the public to radiation."
- **Type 1:** a hidden sealed radioactive source in an area where victims would be confined and unaware of exposure over an extended period time.
- A Type 1 RED is likely to be a strong gamma radiation source that may require lead shielding as the adversary is moving it to the target location. Thus, the package containing an RED is likely to be heavy.
- **Type 2:** While not an actual device, would be the ingestion of radioactive material through food or liquid resulting in internal exposure.

HOW RN MATERIALS BECOME MORC

- The IAEA recognizes two (2) types of radioactive sources which are of particular concern when discussing RN MORC.
- Abandoned Source (Orphaned Source): "A radioactive source, which isnot under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen, or transferred without proper authorization."
- Radioactive sources may also be abandoned to avoid, "cost of ownership e.g., dumping to avoid disposal fees."
- Disused Source: "A radioactive source, which is no longer used, and is not intended to be used, in facilities and activities for which authorization has been granted."

ABANDONED SOURCES IN SCRAP METAL

- Abandoned sources are often discarded with scrap metals sent to recycling facilities
- Many recycling facilities lack radiation detection equipment
- The abandoned sources are melted down with the scrap metal resulting in contamination

RADIOACTIVELY CONTAMINATED PRODUCTS

- Growing number of events have involved the detection of products contaminated with radioactive material.
- Contamination detected in commercial products such as steel sheets, pipes, and manhole covers.
- Contamination detected in consumer products containing metal such as utensils, handbags, belt buckles, and jewellery.
- Usually these products are contaminated with Cs-137, cobalt-60 (Co-60), or iridium-192 (Ir-192).

POTENTIAL CONSEQUENCES OF RADIOACTIVE AND NUCLEAR DEVICE

HEALTH

- Death or serious injury from blast effects or radiation exposure.

ECONOMIC

- Property damage, decontamination, evacuation/relocation.
- Economic disruption such as the closure of businesses or the suspension of international trade.

ENVIRONMENTAL

- Contamination of air, soil, and water resources.
- Disruption of ecosystems.

SOCIETAL

- Effects on human behavior, relationships, and organizations.
- Effects on political processes.
- Suspension of transboundary movements of people.
- Restrictions on movement within a State.

CHRONOLOGY OF A NUCLEAR AND RADIOLOGICAL CRIMINAL ACT

ACQUISITION **MOVEMENT** **USE**

ACQUISITION

- Theft or diversion from a manufacturing, storage, or user facility; or point of use
- Theft while transit
- Acquisition of RN material or devices on the illegal market
- Failed states or disputed region within states
- Acquisition of abandoned radioactive sources

MOVEMENT VECTORS

- Transboundary illicit trafficking vectors include the following:
  - POEs
    - Land border crossings
    - Airports, seaports, and rail terminals

ADVERSARY TACTICS

- Concealment
- Shielding
- Masking
- Evasion
- False documentation
- Use of force
- Close contact
- Misinformation

RADIATION HAZARDS

- The degree of damage to body tissues from radiation depends on several factors:
  - Type of radiation
  - Radiation energy
  - Tissue type
  - Dose
  - Duration of exposure

PERSONAL RADIATION DETECTION (PRD)

- Used to detect small changes in radiation level above the natural background radiation.
- Can be worn by naval or maritime law enforcement personal as it is light weight and portable.
- Once elevated radioactivity is indicated by the PRD additional equipment such as survey meters or RIIDs have to be used.

SURVEY METER

- A handheld radiation detector is used to measure alpha, beta, x-ray and gamma radiation.
- It displays radiation in units of counts per minute, counts per second, microrem or micro-roentgen per hour.
- Additionally, they also detect beta and gamma radiation. A few of the models can detect alpha and neutron radiation emitted from radioactive materials.

RADIATION ISOTOPE IDENTIFIER DEVICE (RIID)

- A radiation Isotope Identifier device (RIID) is a radiation detector which analyzes the energy spectrum to identify the radionuclide that is emitting the radiation.
- Different types of RIIDs available in the market such as HPGe, LaBR, CeBR and CZT.
- Thalium doped Sodium Iodide NAI (TI) RIIDs are easy to use and less expensive than other RIIDs.

RADIATION DETECTION EQUIPMENT

Concept of Operations:

- Initially, there is an indication of an elevated radioactivity on the PRDs. Once it is confirmed that it is not a false alarm, the survey meters and RIIDs are deployed to identify the type of radioactivity and the radioactive source.

RADIATION PORTAL MONITORING (RPM)

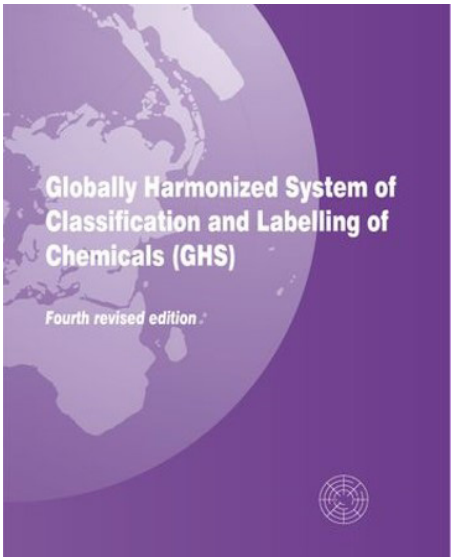
HAZARDOUS SUBSTANCES & LABELLING

REASONS FOR DEVELOPMENT

- Growing international trade
- Need for a uniform worldwide safety standard
- There were different systems for labelling
- Different classifications and therefore different treatment of the same substances and preparations in different countries

HAZARD COMMUNICATIONS AND GHS

- A system for standardizing and harmonizing the classification and labelling of chemicals
- Defines health, physical and environmental hazards of chemicals
- Communicates hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS).
- The GHS itself is not a regulation or a standard
- Establishes agreed hazard classification and communication provisions with explanatory information on how to apply the system



HAZARD CLASSIFICATION

- Classification is the starting point for hazard communication

- Involves the identification of the hazard(s) of a chemical or mixture by assigning a category of hazard/danger

- Hazard Classes
  - 16 classes of physical hazards
  - 10 classes of health hazards
  - 3 classes of environmental hazards

GHS PHYSICAL HAZARDS

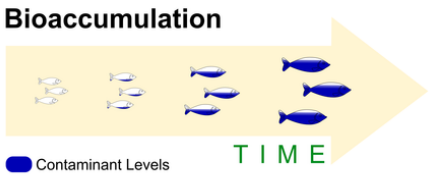
- Explosive substances/mixtures and products
- Flammable gases
- Flammable aerosols
- Oxidizing Gases
- Gases under pressure
- Flammable liquids
- Flammable solids
- Self-reactive substances and mixtures
- Pyrophoric liquids
- Pyrophoric solids
- Self-heating substances and mixtures
- In contact with water = flammable gases
- Oxidizing Liquids
- Oxidizing solids
- Organic peroxides
- Corrosive to metals

GHS HEALTH HAZARDS

- Acute toxicity
- Itching/irritant effect on the skin
- Severe eye damage/eye irritation
- Sensitization of the respiratory tract or skin
- Carcinogenicity
- Germ cell mutagenicity
- Reproductive toxicity
- Specific target organ toxicity (single exposure)
- Specific target organ toxicity (repeated exposure)
- Aspiration hazard

GHS ENVIRONMENTAL HAZARDS

- Acute aquatic toxicity
- Potential or real Bioaccumulation
- Rapid degradability of organic chemicals



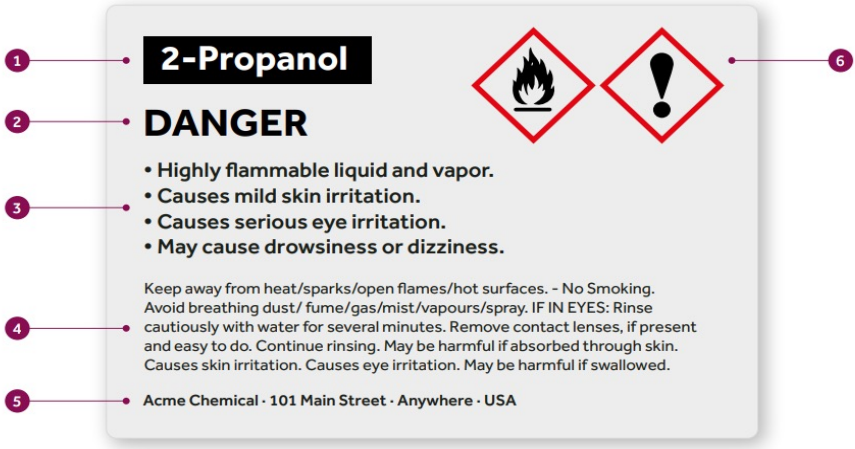
WHAT IS A HAZARDOUS SUBSTANCE

- Dangerous substances and mixtures which can be assigned to a hazard class.
- Explosive substances, mixtures and products.
- Dangerous or explosive substances, mixtures and articles released during use.
- Substances and mixtures which do not meet the previous criteria but which, because of their physicochemical, chemical or toxic properties and the manner in which they are present or used in the workplace, may endanger the health and safety of workers.

GHS LABEL ELEMENTS

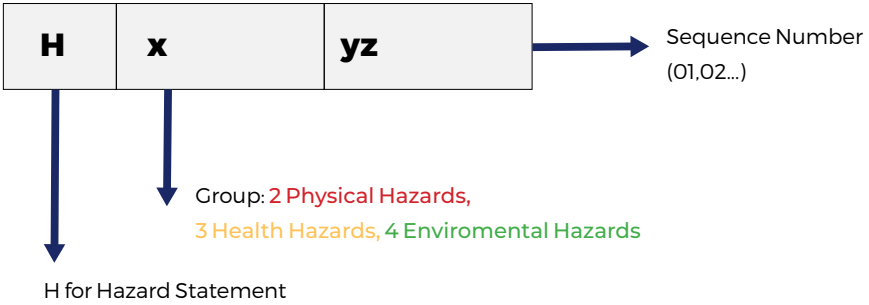
- Product Identifier
- Signal Word (Danger, Warning)
- Hazard Statement (for each hazard class and category)
- Pictogram(s)
- Precautionary Statement (for each hazard class and category)
- Name, Address and Tele. # of chemical manufacturer

GHS LABEL ELEMENTS



CLASSIFICATION OF HAZARD STATEMENTS

- Coding with standardized text module that describes the type and, if applicable, the severity of the hazard.
- Groups of hazard statements: 2 physical hazards, 3 health hazards, 4 environmental hazards
- Examples:
  - H 223: Extremely flammable material
  - H 314: Causes severe skin burns and eye damage
  - H 410: Very toxic to aquatic life with long lasting effects



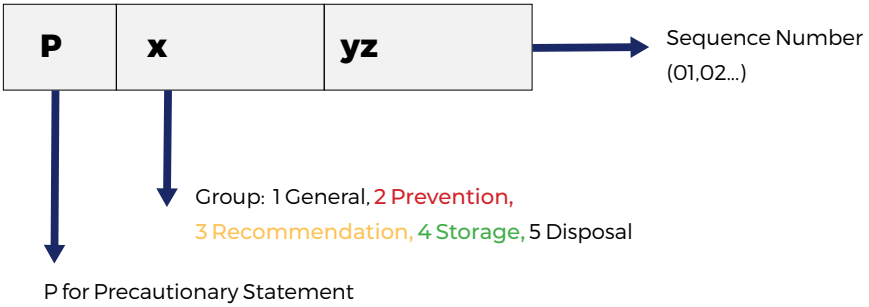
CLASSIFICATION OF HAZARD STATEMENTS

- H202 – Explosive, severe projection hazard.
- H203 – Explosive; fire, blast or projection hazard.
- H204 – Fire or projection hazard.
- H205 – May mass explode in fire.
- H206 – Fire, blast or projection hazard; increased risk of explosion if desensitising agent is reduced.
- H302 – Harmful if swallowed.
- H304 – May be fatal if swallowed and enters airways.
- H310 – Fatal in contact with skin.
- H311 – Toxic in contact with skin.
- H312 – Harmful in contact with skin.
- H400 – Very toxic to aquatic life.
- H410 – Very toxic to aquatic life with long lasting effects.
- H411 – Toxic to aquatic life with long lasting effects.
- H412 – Harmful to aquatic life with long lasting effects.
- H413 – May cause long lasting harmful effects to aquatic life.

INFORMATION – PRECAUTIONARY STATEMENTS

- Groups of precautionary statements: 1 General, 2 Precautions, 3 Recommendations, 4 Storage instructions, 5 Disposal

- Examples:
  - P 232: Protect from moisture
  - P 353: Rinse skin with water/shower
  - H 401: Store in a dry place



PRECAUTIONARY STATEMENTS

- P202 – Do not handle until all safety precautions have been read and understood.
- P210 – Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
- P211 – Do not spray on an open flame or other ignition source.
- P212 – Avoid heating under confinement or reduction of the desensitising agent.

- P310 – Immediately call a POISON CENTER/doctor/ ...
- P311 – Call a POISON CENTER/doctor/...
- P312 – Call a POISON CENTER/doctor/.../if you feel unwell.
- P313 – Get medical advice/attention.

- P402 – Store in a dry place.
- P403 – Store in a well-ventilated place.
- P404 – Store in a closed container.
- P405 – Store locked up.

SIGNAL WORDS

- Signal Words "Danger" or "Warning" are used to emphasize hazards and indicate the relative level of severity of the hazard, assigned to a GHS hazard class and category.
- "Danger" for the more severe hazards
- "Warning" for the less severe hazards.

DANGER

WARNING

SYMBOLS/PICTOGRAMS

- Convey health, physical and environmental hazard information, assigned to a GHS hazard class and category

- The GHS symbols have been incorporated into pictograms for use on the GHS label

- Pictograms will have a black symbol on a white background with a red diamond frame

EXPLODING BOMB GHS01

- Examples of Effects: Explode by fire, shock, friction, heating; danger by fire, air pressure, splinters
- Safety and Security: Do not rub or bump; avoid sparks and heat generation.

FLAME GHS02

- Examples of Effects: Are flammable; liquids form explosive mixtures with air; produce flammable gases with water or are self-flammable.
- Safety and Security: Keep away from open flames and heat sources; close containers tightly.

FLAME OVER CIRCLE GHS03

- Examples of Effects: Oxidizing and intensifying fires: when mixed with flammable substances, explosive mixtures are formed.
- Safety and Security: Keep away from flammable substances and do not mix with them.

GAS CYLINDER GHS04

- Examples of Effects: Gas cylinders under pressure may explode when heated; cryogenic gases produce cold burns
- Safety and Security: Do not heat, with cryogenic gases protective goggles and protective gloves

CORROSIVITY GHS05

- Examples of Effects: Causes damage to metals and causes reversible and irreversible damage to skin, severe eye damage is possible
- Avoid contact; protective goggles/gloves in case of contact with eyes and skin rinse with water

SKULL WITH BONE GHS06

- Examples of Effects: In small quantities, lead immediately to serious health damage or death.
- Safety and Security: Do not inhale, touch or swallow; wear respiratory protection.

EXCLAMATION MARK GHS07

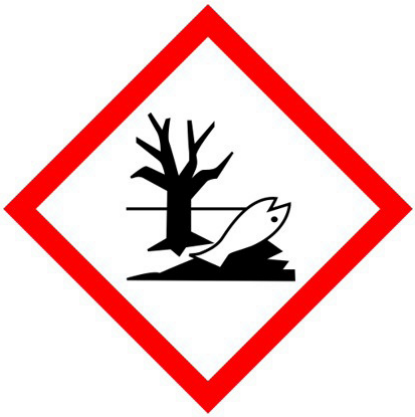
- Examples of Effect: It can cause health damage, irritation to eyes, skin or respiratory organs. Leads to death in large quantities.
-
- Safety and Security: Like skull; In case of skin or eye contact rinse with plenty of water or suitable products.

HEALTH HAZARD GHS08

- Examples of Effects: Have an allergenic, carcinogenic, mutagenic, reprotoxic, toxic to reproduction or organ-damaging
-
- Safety and Security: Wear protective clothing, gloves, eye and mouth protection, respiratory protection before starting work.

ENVIRONMENT GHS09

- Examples of Effects: Harmful, toxic or very toxic, acute or long-term to aquatic organisms
-
- Safety and Security: Only dispose of in hazardous waste, never allow to be released into the environment.



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