First Responder Operations (FRO)

Student Resource Packet

NES, Inc.
1141 Sibley Street, Folsom, CA 95630
(916) 353-2360 / 1-800-NES-ADVISE

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Course Objectives

- This course will prepare employees who are expected to provide defensive measures in the case of a chemical release to:
  - Safely assess, respond to, contain, and control chemical spills
  - Protect human health, the environment, and property

Course Outline

- Regulations
- Employer's Emergency Response Plan
- First On-Scene Actions
- Chemical Hazards
- Toxicology
- Globally Harmonized System (GHS)
- Recognition & Identification
- Emergency Response Guidebook
- Personal Protective Equipment
- Respiratory Protection
- Air Monitoring
- Site Control
- Decontamination
- Offensive & Defensive Measures
- Incident Command
- Termination Procedures

Regulations

OSH Act of 1970

"To assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the Act; by assisting and encouraging the States in their efforts to assure safe and healthful working conditions; by providing for research, information, education, and training in the field of occupational safety and health; and for other purposes."

RCRA

- Resource Conservation and Recovery Act
- Four distinct goals:
  - To protect human health and the environment from the hazards posed by waste disposal
  - To conserve energy and natural resources through waste recycling and recovery
  - To reduce or eliminate, as expeditiously as possible, the amount of waste generated, including hazardous waste
  - To ensure that wastes are managed in a manner that is protective of human health and the environment

CERCLA

- Comprehensive Environmental Response, Compensation, and Liability Act
- Commonly known as SUPERFUND
- Enacted by Congress on December 11, 1980
- Created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment

CERCLA

- Over five years $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites
- Established prohibitions and requirements concerning closed and abandoned hazardous waste sites
- Provided for liability of persons responsible for releases of hazardous waste at these sites

CERCLA

- Established a trust fund to provide for cleanup when no responsible party could be identified
- Authorized two types of response actions:
  - Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response
  - Long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening – these actions can be conducted only at sites listed on EPA's National Priorities List (NPL)

SARA

- Superfund Amendments and Reauthorization Act
- Amended CERCLA on October 17, 1986:
  - Stressed the importance of permanent remedies and innovative treatment technologies in cleaning up hazardous waste sites
  - Required Superfund actions to consider the standards and requirements found in other state and federal environmental laws and regulations
  - Provided new enforcement authorities and settlement tools
  - *[Continued…]*

SARA

- Increased state involvement in every phase of the Superfund program
- Increased the focus on human health problems posed by hazardous waste sites
- Encouraged greater citizen participation in making decisions on how sites should be cleaned up
- Increased the size of the trust fund to $8.5 billion

HMT-USA

- Hazardous Materials Transportation Uniform Safety Act
- HMT-USA requires the Secretary of Transportation to promulgate regulations for the safe transport of hazardous materials in intrastate, interstate, and foreign commerce
- The Secretary also retains authority to designate materials as hazardous when they pose unreasonable risks to health, safety, and/or property

HMT-USA

- The HMT-USA statute also includes provisions to:
  - Encourage uniformity among different state and local highway routing regulations
  - Develop criteria for the issuance of federal permits to motor carriers of hazardous materials
  - Regulate the transport of radioactive materials

FIFRA

- Federal Insecticide, Fungicide, and Rodenticide Act
- Provides federal control of pesticide distribution, sale, and use
- EPA was given authority under FIFRA not only to study the consequences of pesticide usage but also to require users (farmers, utility companies, and others) to register when purchasing pesticides

8 CCR 5192

- Hazardous waste operations and emergency response
- Covers the following operations, unless the employer can demonstrate that the operation does not involve employee exposure or the reasonable possibility for employee exposure to safety or health hazards:
  - Cleanup operations or hazardous substance removal work required by a governmental body, whether federal, state, local, or other, involving hazardous substances that are conducted at uncontrolled hazardous waste sites
  - *[Continued…]*

8 CCR 5192

- Corrective actions involving hazardous waste cleanup operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 U.S.C. 6901. et seq.) and Chapters 6.5 and 6.8 of Division 20 of the California Health and Safety Code
- Voluntary cleanup operations at sites recognized by federal, state, local, or other governmental bodies as uncontrolled hazardous waste sites
- *[Continued…]*

8 CCR 5192

- Operations involving hazardous wastes that are conducted at treatment, storage, and disposal facilities (TSDFs) regulated by 40 CFR Parts 264 and 265 pursuant to RCRA; or facilities regulated by Chapter 6.5 of Division 20 of the California Health and Safety Code; or by agencies under agreement with U.S. E.P.A. to implement RCRA regulations
- Emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard

8 CCR 5192

- Additional statute mandates:
  - Employers to develop and implement a written Health and Safety Program (HASP) for employees involved in hazardous waste operations
  - Employers engaged in hazardous waste operations shall institute a medical surveillance program
  - *[Continued…]*

8 CCR 5192

- Employees who wear a respirator or are a member of a hazardous materials team are required to have a medical examination and consultation on the following schedule:
  - Prior to assignment
  - Once every twelve months – not to exceed two years
  - At termination of employment
  - At development of signs and symptoms of exposure
  - If physician requires increased frequency
- *[Continued…]*

8 CCR 5192

- When addressing hazards:
  - Engineering controls
  - Administrative controls
  - Personal protective equipment

8 CCR 5192(q)

- Emergency response to hazardous substance release
- Emergency Response Plan elements:
  - Pre-emergency planning
  - Personnel roles, lines of authority, training, and communication
  - Emergency recognition and prevention
  - Safe distances and places of refuge
  - Site security and control
  - Evacuation routes and procedures
  - *[Continued…]*

8 CCR 5192(q)

- Decontamination
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- Personal protective equipment (PPE) & emergency equipment
- Emergency response organizations coordination

8 CCR 5192(q)

- Training requirements:
  - First responder, awareness level (FRA)
    - Likely to witness or discover a hazardous substance release and is trained to initiate an emergency response sequence
    - NO FURTHER ACTION BEYOND NOTIFICATION
  - First responder, operations level (FRO)
    - Respond to protect people, the environment, and property
    - Trained to respond in a defensive fashion without trying to stop release
    - Shall receive at least eight hours of initial training
  - *[Continued…]*

8 CCR 5192(q)

- Hazardous materials technician
  - Respond to stop the release
  - Know how to implement the employer's emergency response plan
  - Be able to function within an assigned role in the ICS
  - Shall receive at least 24 hours of initial training
- *[Continued…]*

8 CCR 5192(q)

- Hazardous materials specialist
  - Respond to provide support to technicians
  - Duties require a more directed or specific knowledge of the substance(s) they may be called to contain
  - May also act as site liaison with federal, state, and local government authorities
  - Shall receive at least 24 hours of initial training, plus some specialized training
- *[Continued…]*

8 CCR 5192(q)

- Incident commander / on-scene manager
  - Shall assume control of the incident scene
  - Know and be able to implement the employer's incident command system
  - Know how to implement the employer's emergency response plan
  - Shall receive at least 24 hours of initial training, plus some specialized ICS training
- Shall receive annual refresher training

8 CCR 5192(q)

- Medical surveillance and consultation:
  - Shall have a baseline
  - When exhibiting signs or symptoms

8 CCR 5192 Appendices

- Appendix A – Personal Protective Equipment Test Methods
- Appendix B – General Description and Discussion of the Levels of Protection and Protective Gear
- Appendix C – Compliance Guidelines
- Appendix D – References

Employer's Emergency Response Plan

Employer's Emergency Response Plan

- The general purpose of planning is to act as the first step toward effective response
- The four steps of planning:
  1. ID all hazardous materials emergencies
  2. ID all available resources within / outside of the site
  3. Determine training & equipment needs
  4. Validate the plan by conducting emergency response exercises

Employer's Emergency Response Plan

- The four objectives to consider in ER planning:
  1. Preparedness – continually improve
  2. Response – response actions & IAP implementation
  3. Mitigation – methods for containment or control
  4. Recovery – "back on line" operations

Employer's Emergency Response Plan

- Ultimate goals of a hazmat response that MUST be addressed in the ERP:
  - Life & health
  - Environment
  - Property
- There are two types of plans "required" by federal & state law:
  - Pre-event plans
  - Event-specific plans

Employer's Emergency Response Plan

- Key steps & components of planning:
  - Clearly ID all hazards & risks
  - ID all resources available
  - Conduct needs assessment
  - Determine best use of resources
  - Identify roles & responsibilities
  - Identify & integrate with local ER plan
  - Establish lines of authority & methods of communication
  - *[Continued…]*

Employer's Emergency Response Plan

- Use one operational system for the ER response organization, same as local agencies
- Determine isolation zones for various releases & ID safe refuge areas
- ID evacuation routes & safe procedures
  - Site security & control procedures
- Define alarm systems, monitoring & method of activation
  - Notification procedures & checklists
- *[Continued…]*

Employer's Emergency Response Plan

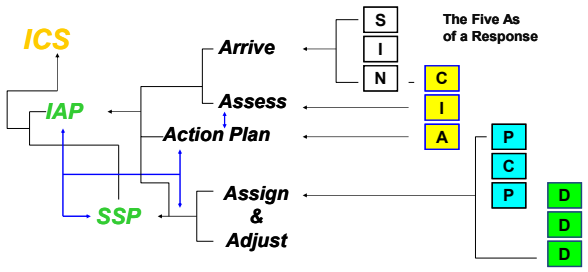
- Procedures for handling the ER & checklists
- Medical monitoring, emergency treatment & first aid procedures
- Personal protective equipment
- Decontamination & disposal procedures
- Termination & recovery procedures
- Reference medical surveillance program
- Training requirements, frequency & periodic review of the ERP and SOPs

Employer's Emergency Response Plan

Strategic Objectives & Elements

- Safety
- Isolate & deny entry
- Notification
- Command
- Identification & hazard assessment
- Action planning
- Protective equipment
- Containment & control
- Protective actions
- Decontamination
- Disposal
- Documentation

Incident Action Plan



Development of a Site Safety Plan

- A written Site Safety Plan (SSP) is required by law at all HAZMAT incidents:
  - All phases of the incident are to be addressed
  - All personnel are to be informed of contents
- Lack of planning = poor management
- Conduct thorough site safety evaluation:
  - All aspects of personnel safety
  - Management structure

Development of a Site Safety Plan

- Purpose of a Plan:
  - Ensure scene safety
  - Establish SOPs
  - Establish common structure
- Provide a briefing document:
  - Objectives
  - Plans
  - Contingencies

29 CFR 1910.120; 8 CCR 5192

First On-Scene Actions

FRO Training Needs

- Responders must have the ability to:
  - Recognize potential/actual hazardous materials incidents
  - Safely isolate & make proper notifications
  - Conduct initial identification & assessment
  - Initiate command
  - Conduct containment & protective actions
  - Contribute to effective & efficient response

"Safe" Acronym

- **S**afety first, last, and always
- **A**nalyze all information per your needs
- **F**ocus on FRO safety & competence
- **E**nthusiastic involvement by all

First Operational Priority: Safety

- The individual in charge of the ICS shall designate a safety official:
  - Who is knowledgeable in the operations being implemented at the emergency response site
  - With specific responsibility to identify and evaluate hazards and to provide direction with respect to the safety of the operations for the emergency at hand

29 CFR 1910.120(q)(3); 8 CCR 5192(q)(3)

First Operational Priority: Safety

- When activities are judged by the safety official to be an IDLH and/or to involve an imminent danger condition, the safety officer shall have the authority to alter, suspend, or terminate those activities
  - The safety official shall immediately inform the individual in charge of the ICS of any action needed

29 CFR 1910.120(q)(3); 8 CCR 5192(q)(3)

First Operational Priority: Safety

- Do not unnecessarily expose yourself or others
- Avoid contact with the liquids, vapors, gases, etc.
- Avoid areas with odors
- Stay upwind, upgrade & uphill and at a safe distance
- Do not enter a spill area if safety is compromised
- Do not rescue someone unless personal safety can be maintained

First Operational Priority: Safety

- No matter where the incident happens, we must protect our lives and the lives of others
- Proper evacuation during the first stage of an incident can help to reduce the potential of a catastrophic event
- Ask:
  - What are your company's evacuation procedures?
  - What is your company's alarm and notification system?

First Operational Priority: Safety

- Three techniques to ensure safety and positive attitude:
  1. Safe approach – approach the incident from:
     - Upwind, upgrade/uphill & upstream
     - Never travel through the spill
     - Use the Emergency Response Guidebook

  [Continued…]

First Operational Priority: Safety

2. Safe assessment
   - From a location that does not put you at risk
   - Use binoculars to identify/assess incident
   - Position vehicles headed away from incident
   - Observe the area
3. Key safety guides for all responders to follow – use standard operation procedures for responder safety
   - Be cautious – treat materials as hazardous until proven otherwise
   - Isolate and deny entry (limit numbers of responders)
   - Eliminate all ignition sources (incl. flares) near incident area

Second Operational Priority: Isolation

- Responders can safely attempt to isolate and deny entry by establishing perimeters & control zones via pre-established guidelines in the ERP/EAP/SSP or by utilizing the ERG
- The dilemma of distance in safety vs. isolation:
  - Distance is safety's #1 ally but isolation's #1 enemy

Third Operational Priority: Notification

- Once proper isolation has been established and the potential for loss of life has been eliminated, we can focus on notification
- Notification can include:
  - On-site HAZMAT team
  - Off-site contractors
  - Outside governmental agencies
  - Local emergency services

Required Notification – NRC

"Notice of an oil discharge or release of a hazardous substance in an amount equal to or greater than the reportable quantity must be made immediately . . . to the NRC duty . . ."

40 CFR 300.125(c)

Required Notification – CUPA

". . . provide an immediate, verbal report of any release or threatened release of a hazardous material to the Administering Agency and the [OES] . . . The [AA] may designate a call to . . . 911 . . . as meeting the requirement to call the [AA]."

19 CCR 2703

Required Notification – OES

" . . . immediately report any release or threatened release of a hazardous material to the administering agency and the [Office of Emergency Services]."

HSC 25507

Required Notification – Transportation

" . . . each carrier who transports hazardous materials (including hazardous wastes) shall give notice in accordance with paragraph (b) of this section after each incident . . . "

49 CFR 171.15; 13 CCR 1166

Required Notification – Schools

"Emergency rescue personnel . . . shall immediately advise the superintendent . . . where the location of the release or threatened release is within one-half mile of a school."

HSC 25510.3

Required Notification – Oil

"Any local or state agency responding to a spill of oil shall notify the Office of Emergency Services, if notification . . . has not occurred."

CGC 8670.26

Risks at an Incident

- Hazmat incidents present three main risks:
  - Health/toxicity
  - Fire/explosion
  - Asphyxiation

- Responding poorly to a hazmat incident can have negative outcomes:
  - Life/health
  - Environment
  - Property

FRO Responsibilities

- FRO key roles:
  - Respond SAFELY & COMPETENTLY within:
    - Level of training
    - Resources
    - Capabilities
- Fundamental difference in hazmat response:
  - You MUST respond:
    - Slowly
    - Methodically
    - Safely

REMEMBER!

- The goals of the response:
  - Save lives & limit casualties
  - Protect the environment
  - Limit damage to property
  - Restore area to normal as soon as possible
- Be part of the solution, not the problem!
- Know your limits!

Chemical Hazards

Chemical & Physical Properties

- Knowing the chemical and physical properties of the materials at your workplace helps to determine the appropriate response and handling techniques
- Chemical and physical properties are related to state of matter changes

Solid

Liquid

Gas

Physical Properties

- Boiling point
- Melting point
- Solubility
- Explosive/flammable limits
- Flash point
- Specific gravity
- Vapor density
- Vapor pressure
- Corrosive
- Sublimation

Boiling Point

- Boiling point is the temperature at which a liquid changes to gas/vapor
- Q: Which is more hazardous, a high or a low boiling point?

Melting Point / Freezing Point

- Melting point is the temperature at which a solid changes to liquid
- Freezing point is the temperature at which a liquid changes to a solid
  - Same temperature as melting point

Solubility

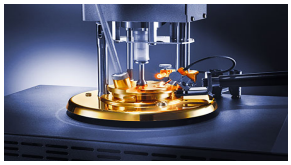
Solubility is the ability of one substance to blend, mix, or combine uniformly with another substance.

Flammable Range

- Flammable range is the concentration range of gas/vapor that will burn or explode if an ignition source is introduced
  - Difference between LEL and UEL is the flammable range
  - The lower the LEL, the lower the vapor to air ratio needed to support combustion

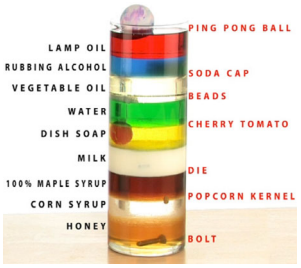
Flash Point

- Flash point is the temperature at which a liquid or particular organic compound will give off sufficient vapors to form an ignitable mixture in air
- The lower the flash point, the more volatile a substance is considered



Specific Gravity

- Specific gravity is the ratio of the density of a solid or liquid compared to another reference material
- Reference material is usually water, where water = 1
  - < 1 = less dense than water (floats)
  - > 1 = more dense than water (sinks)



Vapor Density

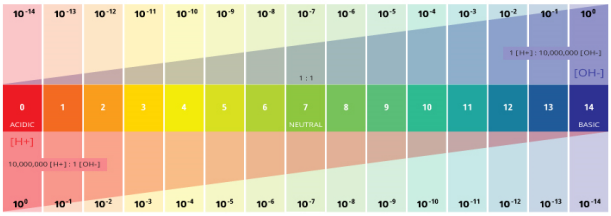
- Vapor density is the ratio of the density of air compared to another material
- Air = 1
  - < 1 = lighter than air (floats)
  - > 1 = heavier than air (sinks)

Vapor Pressure

- Vapor pressure (VP) is the pressure exerted by a chemical vapor, in air, at a given temperature and pressure
- VP is commonly measured using “mmHg” or “atm” (atmosphere)
  - 1 atm = 760 mmHg
- Vapor pressure also corresponds to how fast a substance (liquid or solid) will evaporate (change from a liquid to a gas) once released to the atmosphere

Corrosiveness

Corrosiveness is a substance’s ability to corrode metal or deteriorate skin tissue.

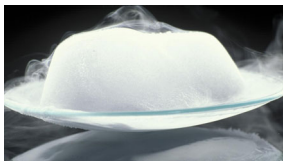


Concentration of Hydrogen ions compared to distilled water	1/10,000,000	14	Liquid drain cleaner, Caustic soda	Examples of solutions and their respective pH
	1/1,000,000	13	bleaches, oven cleaner	
	1/100,000	12	Soapy water	
	1/10,000	11	Household Ammonia (11.9)	
	1/1,000	10	Milk of magnesium (10.5)	
	1/100	9	Toothpaste (9.9)	
	1/10	8	Baking soda (8.4), Seawater, Eggs	
	0	7	"Pure" water (7)	
	10	6	Urine (6) Milk (6.6)	
	100	5	Acid rain (5.6) Black coffee (5)	
	1,000	4	Tomato juice (4.1)	
	10,000	3	Grapefruit & Orange juice, Soft drink	
	100,000	2	Lemon juice (2.3) Vinegar (2.9)	
	1,000,000	1	Hydrochloric acid secreted from the stomach lining (1)	
	10,000,000	0	Battery Acid	

Sublimation

Sublimation is the passing of a solid material directly to the vapor state without first melting.

Iodine Crystals



Dry Ice

Incompatibility

Incompatibility refers to how substances adversely interact with other materials.

Organics

Fuels
Flammable liquids
Oils
Paints
Solvents

Oxidizers

Bromates
Nitrates
Perchlorates
Peroxides
Persulfates

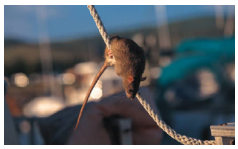
Toxicology

Toxicology

Toxicology is the study of the adverse health effects of chemicals on living systems, whether they be human, animal, plant, or microbe.

Limits of Toxicology

- Tests are usually performed on animals
  - Variation between species
- Limited human data (volunteer, trial, accidental exposure)



Routes of Entry

- Inhalation: the major route of entry for most chemicals in the form of vapors, gases, mists, or particulates
- Absorption (via skin, eye/mucous membrane): many chemicals can cross the skin barrier and be absorbed into the blood system
- Ingestion: chemicals may inadvertently get into the mouth and be swallowed
- Injection: substances may enter the body if the skin is penetrated or punctured by contaminated objects

Acute vs. Chronic Exposure

Acute Exposure

- Short duration
- Often involves high concentration
- One-time, limited, or short-term exposure
- Effects may not manifest immediately
- Usually reversible

Chronic Exposure

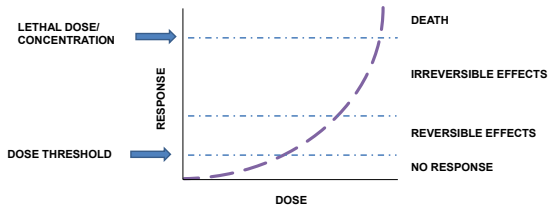
- Extended time with low concentration
- Continuous, repeated, or long-term
- Often irreversible damage

Measurements of Toxicity

- Dose-response is a comparison of an organism's response to a given material at a specific dose
- Dose-response curve
  - Toxic material normally thought of as harmless may induce a toxic response if taken into the body in sufficient amounts

Measurements of Toxicity

Dose-Response Relationship



Measurements of Toxicity

Lethal Dose

- LD_{50}
- Only deaths measured
- Expressed in mg/kg
- Routes of entry:
  - Absorption
  - Ingestion

Lethal Concentration

- LC_{50}
- Only deaths measured
- Expressed in ppm or mg/m^3
- Route of entry:
  - Inhalation

Exposure Limits

- Ceiling is the threshold above which an employee's exposure to any OSHA-listed substance is not permitted
  - Exposure limit preceded by "C"
- Permissible exposure limit (PEL)
  - Legal limit set by OSHA
  - Based on a time-weighted average (TWA) 8-hour day

Exposure Limits

- Short-term exposure limit (STEL)
  - 15-minute TWA exposure that should not be exceeded at any time during a workday
    - Should occur no more than four times per day
    - At least 60 minutes between successive exposures in this range

NIOSH – REL

- Recommended exposure limit (REL)
  - TWA up to a 10-hour workday / 40-hour workweek
  - "C" – ceiling concentrations
  - "ST" – STEL
  - "Ca" – potential occupational carcinogen

National Institute for Occupational Safety and Health
NIOSH

NIOSH – IDLH

- Immediately dangerous to life or health (IDLH) refers to an airborne concentration that:
  - Poses an immediate threat to life and health;
  - Causes irreversible or delayed adverse health effects; OR
  - Inhibits egress efforts from a dangerous atmosphere

CDC
Centers for Disease Control and Prevention

ACGIH – TLV-TWA

- The American Conference of Governmental Industrial Hygienists (ACGIH) creates exposure limits based on current research and information
- Threshold limit value – TWA (TLV-TWA)
  - Based on 8-hour workday / 40-hour workweek
  - Upper limit of a toxic material to which a person can be repeatedly exposed based on IH guidelines
  - Typically stricter than PELs and RELs

ACGIH

ACGIH – STEL

- STEL
  - 15-minute TWA exposure that should not be exceeded at any time during a workday
  - Should be less than 15 minutes
  - Should occur no more than four times per day
  - Should be at least 60 minutes between successive exposures in this range

Degree of Exposure

- Other factors of exposure include:
  - Genetics
  - Sex (male/female)
  - Health
  - Age (newborn, child, adult, elderly)
  - Environment (day, night, temperature)
  - Pregnancy

Kinetics

- Kinetics refers to the distribution of a chemical through the body
  - Blood system: arteries, capillaries, veins
  - Lymphatic system: completely separate circulation system
  - Mucous membranes

Biotransformation

- Biotransformation is the process by which a chemical is transformed to another chemical within the body
- Elimination is removal of a substance (by metabolism or detoxification) via any of several different pathways:
  - Perspiration (sweating)
  - Exhalation (breathing)
  - Excretion (urination/defecation)
  - Expulsion (vomiting)

Toxic Respiratory Hazards: Asphyxiants

- Simple asphyxiants are gases that displace air at high concentrations
  - E.g., nitrogen
- Chemical asphyxiants are gases that prevent tissue from getting enough oxygen
  - E.g., carbon monoxide

Toxic Respiratory Hazards: Irritants

- Irritants are chemicals that aggravate the air passages, causing constriction of the pathways
  - Can also cause fluid buildup in the lungs (pulmonary edema) and/or infection

Upper Respiratory Irritants

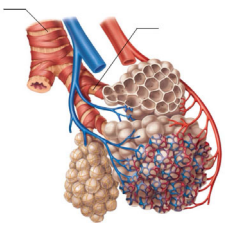
- Upper respiratory irritants are substances that affect the upper respiratory tract (nose, mouth, trachea, lungs)
  - Usually water-soluble
  - Examples: anhydrous ammonia, bromine, hydrogen chloride

Lower Respiratory Irritants

- Lower respiratory irritants are substances that affect the part of the lungs where oxygen exchanges with cells
  - Usually not water-soluble
  - Examples: acrolein, nitrogen dioxide, phosphine

Systemic Toxins

- Systemic toxins are chemicals that target specific organs or systems throughout the body and will affect:
  - Central nervous system
  - Circulatory system
  - Liver (hepato-toxic agents)
  - Kidney (nephro-toxic agents)
  - Spleen
  - Reproductive organs



External Toxins

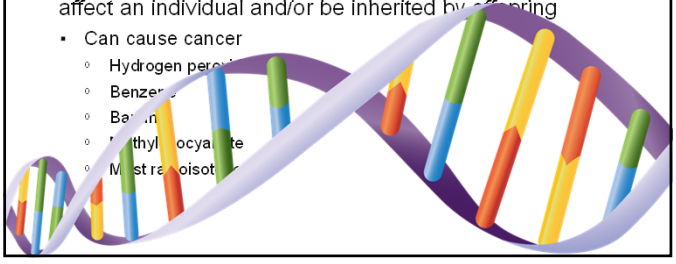
- Skin – largest organ of the human body
  - Solvents, oils, metals, corrosives
- Eyes – most commonly affected organ
  - Caustics, acids, solvents, oils, lachrymators

Special Toxins: Carcinogens

- Carcinogens are materials that cause uncontrolled cell growth
- Unlike other toxins
  - Very small amounts over extended periods
  - Effects usually not evident for years
  - More likely to occur after chronic exposure

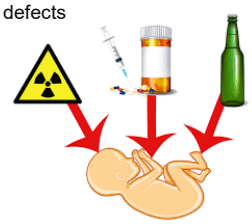
Special Toxins: Mutagens

- Mutagens cause changes in genetic code, which can affect an individual and/or be inherited by offspring
  - Can cause cancer
    - Hydrogen perox
    - Benzen
    - Barbitu
    - Methyl isocyanate
    - Most radioisotop



Special Toxins: Teratogens

- Teratogens are agents causing non-lethal congenital malformations
  - A baby will usually be born with birth defects
  - Examples:
    - Lead
    - Mercury compounds
    - Retinol
    - Thalidomide
    - Warfarin



Globally Harmonized System (GHS)

Globally Harmonized System (GHS)

- Enhances the protection of human health and the environment
- Provides a recognized framework for those countries without an existing system
- Reduces the need for testing and evaluation of chemicals
- Facilitates international trade in chemicals whose hazards have been properly assessed and identified on an international basis

Signal Words

- The signal word indicates the relative degree of severity of a hazard
- The signal words used in the GHS are:
  - "Danger" for the more severe hazards
  - "Warning" for the less severe hazards
- Signal words are standardized and assigned to the hazard categories within endpoints
- Some lower level hazard categories do not use signal words
- Use only one signal word corresponding to the class of the most severe hazard

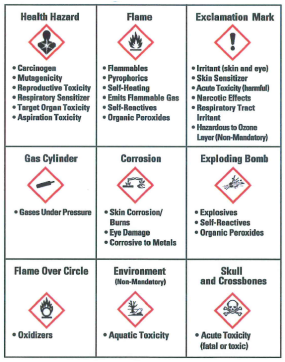
The Basic Parts of A GHS-Compliant Label

1. **Product Identifier** - Should match the product identifier on the Safety Data Sheet.
2. **Signal Word** - Either use "Danger" (severe) or "Warning" (less severe)
3. **Hazard Statements** - A phrase assigned to a hazard class that describes the nature of the product's hazards
4. **Precautionary Statements** - Describes recommended measures to minimize or prevent adverse effects resulting from exposure.
5. **Supplier Identification** - The name, address and telephone number of the manufacturer or supplier.
6. **Pictograms** - Graphical symbols intended to convey specific hazard information visually.

Sample label courtesy of Weber Packaging Solutions • www.weberpackaging.com

HCS Pictograms and Hazards

- Health Hazard
- Flame
- Exclamation Mark
- Gas Cylinder
- Corrosion
- Exploding Bomb
- Flame-Over-Circle
- Environment (non-mandatory)
- Skull-and-Crossbones



Safety Data Sheets

- Safety Data Sheets (SDSs) were formerly called *Material* Safety Data Sheets
- Produced for each hazardous chemical to communicate information on physical, health, or environmental hazards


Safety Data Sheet

SECTION 1: Identification

Conventional Gasoline

SECTION 2: Hazard identification

Label Elements

DANGER

Safety Data Sheets

- Sections 1 – 8:
  - General information
- Sections 9 – 11 and 16:
  - Technical and scientific information
  - Date of preparation or last revision
- Sections 12 – 15:
  - OSHA will not enforce the contents of these sections

Recognition & Identification

Recognition & Identification of Hazardous Materials

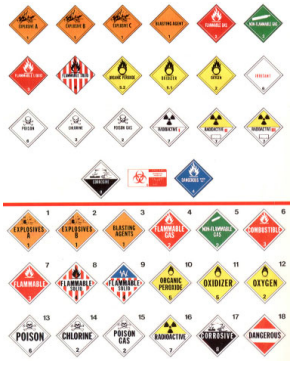
- Occupancy and locations
- Container shapes, markings, and colors
- DOT placarding and labeling
- Shipping papers
- NFPA 704 Standard System

Recognition & Identification of Hazardous Materials

- Occupancy and/or locations:
  - Applies to fixed sites/facilities (manufacturing, industrial, storage, railroad yards)
  - Obvious vs. non-obvious repositories of hazmats
  - Local planning based on knowing hazmats are present at fixed locations
  - Occupancy defined by usage (office, industrial, mercantile, warehouse)
  - Location defined as specific address, area, etc.

Container Markings & Colors

- Systems include:
  - Container markings
  - Hazard Communication (HazCom) systems
  - Military system
  - Color coding
- DOT markings on outside of packages (see DOT Chart 16):
  - Descriptive name
  - ID number
  - Cautions
  - UN or NA numbers



Hazard Materials Identification System (HMIS)

- Used in the workplace to:
  - Meet OSHA Right-to-Know requirements
  - Provide PPE information
  - Meet OSHA HazCom Standard in conjunction with specific training
- Differs from NFPA and EPA:
  - Hazard ranking different from NFPA 704
  - Protective Equipment Index different from EPA Levels of Protection

Military System

- Addresses fixed locations
- Used in military installations, not in transportation
- Relevant to responders at or associated with DoD installations

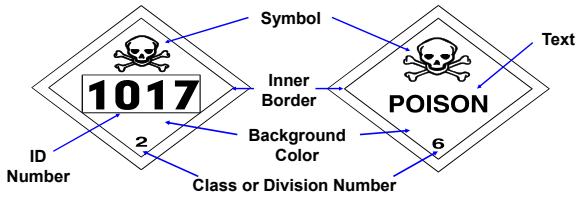
DOT Placard & Labeling System

- DOT regulates ~2,500 hazardous materials offered for transportation in commerce
- DOT Hazardous Materials Table in 49 CFR 172.101
- Diamond-shaped labels, 4 inches on each side, required to be affixed on two sides of non-bulk containers
- Diamond-shaped placards, 10 ¾ inches on each side, required to be placed on bulk containers

DOT Placard & Labeling System

- Placards must appear on all four sides of the vehicle and must contain four pieces of identifying information:
  - Symbol or pictograph located in the upper quadrant
  - UN hazard classification number and division number located in the lower quadrant
  - Hazard class or four-digit identification number located across the center
  - Background color

DOT Placard & Labeling System



DOT Placard & Labeling System

- Class or division numbers do not appear on subsidiary risk placards:
  - There are two placarding tables – placards are required depending on which table a hazardous material is assigned to
  - Vehicles transporting Placarding Table 1 materials must be placarded regardless of quantity
  - Vehicles transporting Placarding Table 2 commodities > 1,001 lb must be placarded

DOT Placard & Labeling System

- Dangerous placard:
  - 1,001 lb (454 kg) gross weight of two or more categories of hazardous materials listed in Table 2
  - Non-bulk packaging with two or more categories that require different placards specified in Table 2 may be placarded with the "Dangerous" placard
    - When 2,205 lb or more of one category of material is loaded at one loading facility, apply the placard specified in Table 2

DOT Placard & Labeling System

DOT placards & labels generally indicate a primary hazard.

DOT placards are:
- Diamond-shaped; 10 3/4" on each side
- Affixed to both sides and ends of the vehicle

10 3/4" diamond-shaped placard

4" diamond-shaped labels

DOT labels are:
- Diamond-shaped; 4" on each side
- On two sides of the container near the shipping name of the material
- Secondary hazards must be labeled

Problems with DOT marking:
- Secondary hazards may not be identified
- Degree or severity of a hazard is not apparent for most classes
- Enforcement is difficult

Classification

- Class 1 – Explosives
- Class 2 – Gases
- Class 3 – Flammable Liquids
- Class 4 – Flammable Solids, Spontaneously Combustible & Dangerous When Wet
- Class 5 – Oxidizers & Organic Peroxide
- Class 6 – Poisonous Materials & Infectious Substances
- Class 7 – Radioactive Materials
- Class 8 – Corrosive Materials
- Class 9 – Miscellaneous Hazardous Materials

49 CFR – Table 1 Materials

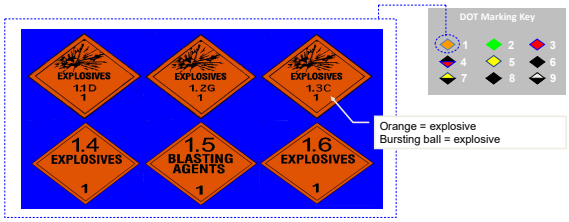
Table 1 materials must always be placarded with their primary hazard placards, regardless of the amount being transported.

DOT Hazard Categories

- Explosive 1.1
- Explosive 1.2
- Explosive 1.3
- Poisonous Gas (Class 2.3)
- Dangerous When Wet (Class 4.3)
- Organic Peroxides, Type B, Temperature Controlled (Class 5.2)
- Poison (Class 6.1; those poisons that are inhalation hazards only)
- Radioactive (Class 7; those substances in Radioactive III packaging only)

DOT Marking System

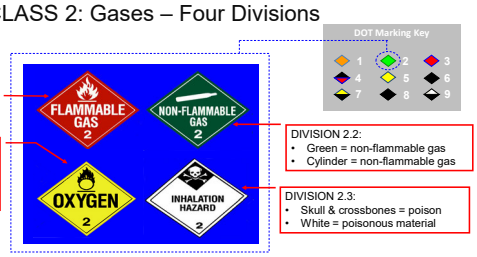
CLASS 1: Explosives – Six Divisions



EXAMPLES: TNT, dynamite, black powder

DOT Marking System

CLASS 2: Gases – Four Divisions



DIVISION 2.1:
- Red = flammable/ combustible
- Flame = flammable

- OXYGEN: may be used in lieu of non-flammable placard
- Flaming circle = oxidizer
- Yellow = oxygen

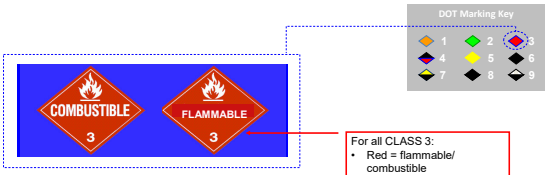
DIVISION 2.2:
- Green = non-flammable gas
- Cylinder = non-flammable gas

DIVISION 2.3:
- Skull & crossbones = poison
- White = poisonous material

EXAMPLES: argon, chlorine, helium, nitrogen, oxygen, propane

DOT Marking System

CLASS 3: Flammable or Combustible Liquids – Four Divisions



For all CLASS 3:
- Red = flammable/ combustible
- Flame = flammable

EXAMPLES: gasoline, diesel fuel, acetone

DOT Marking System

CLASS 4: Flammable Solids, Spontaneously Combustible & Dangerous When Wet

DIVISION 4.1:
- White with red stripes = flammable solid
- Flame = flammable

DIVISION 4.2:
- White over red = spontaneous combustion
- Flame = flammable

DIVISION 4.3:
- Blue = dangerous when wet
- Flame = flammable

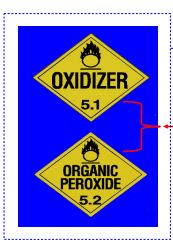
EXAMPLES: nitrocellulose, magnesium turning, calcium carbide, potassium, sodium metal, self-heating material

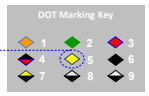
DOT Marking System

CLASS 5: Oxidizers / Organic Peroxides

OXIDIZER (5.1) EXAMPLES: hydrogen peroxide, potassium nitrate, sodium persulfate

ORGANIC PEROXIDE (5.2) EXAMPLES: dibenzoyl peroxide, methyl ethyl ketone peroxide (MEKP), peroxyacetic acid

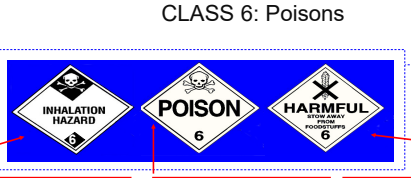


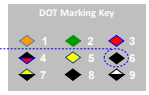


DIVISIONS 5.1 & 5.2:
- Yellow indicates oxidizer (including oxygen) or organic peroxide
- Circle with flame indicates oxidizing material or organic peroxide

DOT Marking System

CLASS 6: Poisons





DIVISION 6.1:
- White = poisonous material
- Skull & crossbones = poisonous material

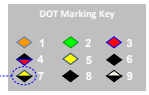
POISON:
- White = poisonous material

KEEP AWAY FROM FOOD:
- White = poisonous material
- Wheat chaff with X = keep away from foodstuffs

EXAMPLES: chloropicrin (tear gas), arsenic

DOT Marking System

CLASS 7: Radioactive

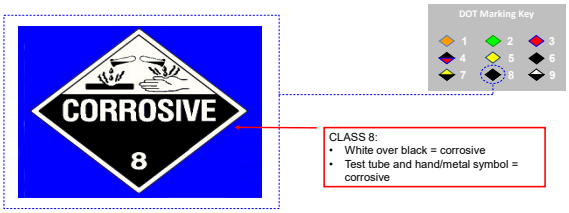


CLASS 7:
- Yellow over white = radioactive material
- Trefoil (propeller) = radioactive material

EXAMPLES: cobalt, uranium hexafluoride

DOT Marking System

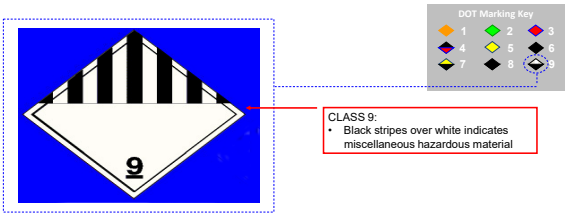
CLASS 8: Corrosive Materials



EXAMPLES: sulfuric acid, nitric acid, hydrochloric acid, sodium hydroxide

DOT Marking System

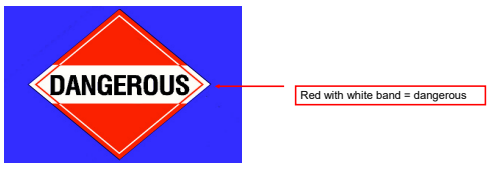
CLASS 9: Miscellaneous Dangerous Materials



EXAMPLES: dry ice, molten sulfur, PCBs

DOT Marking System

"DANGEROUS" Placard



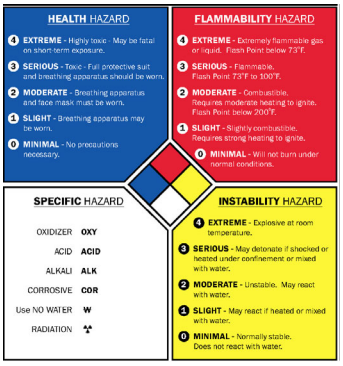
Used if two or more Table 2 materials with a combined weight of more than 1,001 lb are being transported

Recognition & Identification of Hazardous Materials

- DOT shipping papers are critical to the emergency responder at a transportation incident
- Various types of shipping papers for hazardous materials:
  - Highway – Bill of Lading
  - Rail – Waybill Consist
  - Water – Dangerous Cargo Manifest
  - Air – Airbill

Recognition & Identification of Hazardous Materials

- NFPA 704 Standard for Identification of the Fire Hazards of Materials
- Displays:
  - General hazards
  - Degree of severity of toxicity
  - Flammability
  - Reactivity
  - Special information



Recognition & Identification of Hazardous Materials

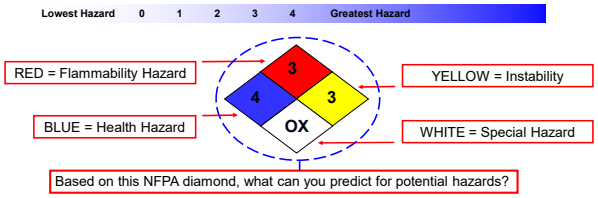
- NFPA scope:
  - Applies to facilities that manufacture, store, and/or use hazardous materials
  - Concerned with health, fire, reactivity, and other related hazards created by short-term exposure as might be encountered under fire or related emergency conditions
  - DOES NOT APPLY TO TRANSPORTATION

Recognition & Identification of Hazardous Materials

- NFPA objective:
  - To provide on-the-spot information necessary to safeguard the lives of fire fighting personnel during an incident

Recognition & Identification of Hazardous Materials

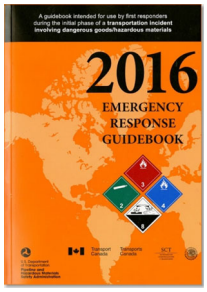
The NFPA marking system uses a diamond divided into four color-coded areas with numerals indicating degree of hazard.



Based on this NFPA diamond, what can you predict for potential hazards?

Emergency Response Guidebook

Emergency Response Guidebook



Yellow Section

- This section contains an index list of hazardous materials in numerical order of ID number
  - This is the UN or NA number that appears on the shipping paper and container

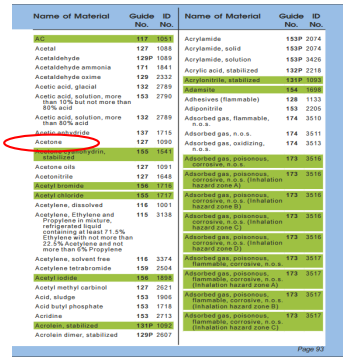
ID No.	Guide No.	Name of Material
1070	122	Nitrous oxide, compressed
1071	119	Oil gas
1071	119	Oil gas, compressed
1072	122	Oxygen
1072	122	Oxygen, compressed
1073	122	Oxygen, refrigerated liquid (cryogenic liquid)
1075	115	Butane
1075	115	Butylene
1075	115	Isobutane
1075	115	Isobutylene
1075	115	Liquefied petroleum gas
1075	115	LPG
1075	115	Petroleum gases, liquefied
1075	115	Propane
1075	115	Propylene
1076	125	CG
1076	125	DP
1076	125	Phosgene
1077	115	Propylene
1078	126	Dispersant gas, n.o.s.
1078	126	Refrigerant gas, n.o.s.
1079	125	Sulfur dioxide
1079	125	Sulphur dioxide
1080	126	Sulfur hexafluoride
1080	126	Sulphur hexafluoride
1081	116P	Tetrafluoroethylene, stabilized
1082	119P	Refrigerant gas R-1113
1082	119P	Trifluorochloroethylene, stabilized
1083	118	Trimethylamine, anhydrous
1085	116P	Vinyl bromide, stabilized
1086	116P	Vinyl chloride, stabilized
1087	116P	Vinyl methyl ether, stabilized
1088	127	Acetal
1089	129P	Acetaldehyde
1090	127	Acetone
1091	127	Acetone oils
1092	131P	Acrolein, stabilized
1093	131P	Acrylonitrile, stabilized
1098	131	Allyl alcohol
1099	131	Allyl bromide
1100	131	Allyl chloride
1104	129	Amyl acetates
1105	129	Pentanols
1106	132	Amylamine
1107	129	Amyl chloride
1108	128	n-Amylene
1108	128	1-Pentene
1109	129	Amyl formates
1110	127	n-Amyl methyl ketone
1110	127	Methyl amyl ketone
1111	130	Amyl mercaptan
1112	140	Amyl nitrate
1113	129	Amyl nitrite
1114	130	Benzene
1120	129	Butanols
1123	129	Butyl acetates
1125	132	n-Butylamine
1126	130	1-Bromobutane
1126	130	n-Butyl bromide
1127	130	n-Butyl chloride
1127	130	Chlorobutanes

Page 29

ID Number

Blue Section

- This section contains an index list of hazardous materials in alphabetical order of material name
  - This is the proper shipping name, which is on the shipping paper and container



Name of Material	Guide No.	ID No.
AC	117	1051
Acetal	127	1088
Acetaldehyde	129P	1089
Acetaldehyde ammonia	171	1841
Acetaldehyde oxime	129	2332
Acetic acid, glacial	132	2789
Acetic acid, solution, more than 10% but not more than 80% acid	153	2790
Acetic acid, solution, more than 80% acid	132	2789
Acetic anhydride	137	1715
Acetone	127	1090
Acetone cyanohydrin, stabilized	155	1541
Acetone oils	127	1091
Acetonitrile	127	1648
Acetyl bromide	156	1716
Acetyl chloride	155	1717
Acetylene, dissolved	116	1001
Acetylene, Ethylene and Hydrogen mixture, refrigerated liquid containing at least 71.5% Ethylene with not more than 22.5% Acetylene and not more than 6% Propylene	115	3138
Acetylene, solvent free	116	3374
Acetylene tetrabromide	159	2504
Acetyl iodide	156	1898
Acetyl methyl carbinol	127	2621
Acid, sludge	153	1906
Acid butyl phosphate	153	1718
Acridine	153	2713
Acrolein, stabilized	131P	1092
Acrolein dimer, stabilized	129P	2607

Name of Material	Guide No.	ID No.
Acrylamide	153P	2074
Acrylamide, solid	153P	2074
Acrylamide, solution	153P	3426
Acrylic acid, stabilized	132P	2218
Acrylonitrile, stabilized	131P	1093
Adamsite	154	1698
Adhesives (flammable)	128	1133
Adiponitrile	153	2205
Adsorbed gas, flammable, n.o.s.	174	3510
Adsorbed gas, n.o.s.	174	3511
Adsorbed gas, oxidizing, n.o.s.	174	3513
Adsorbed gas, poisonous, corrosive, n.o.s.	173	3516
Adsorbed gas, poisonous, corrosive, n.o.s. (inhalation hazard zone A)	173	3516
Adsorbed gas, poisonous, corrosive, n.o.s. (inhalation hazard zone B)	173	3516
Adsorbed gas, poisonous, corrosive, n.o.s. (inhalation hazard zone C)	173	3516
Adsorbed gas, poisonous, corrosive, n.o.s. (inhalation hazard zone D)	173	3516
Adsorbed gas, poisonous, flammable, corrosive, n.o.s.	173	3517
Adsorbed gas, poisonous, flammable, corrosive, n.o.s. (inhalation hazard zone A)	173	3517
Adsorbed gas, poisonous, flammable, corrosive, n.o.s. (inhalation hazard zone B)	173	3517
Adsorbed gas, poisonous, flammable, corrosive, n.o.s. (inhalation hazard zone C)	173	3517

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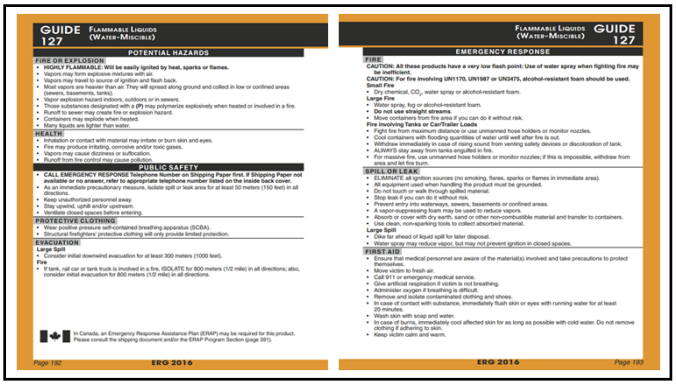
Proper Shipping Name

Orange Section

- This section is the most important section of the guidebook because it is where all safety recommendations are provided
- The guide section has two pages associated with it
- There are three sections included on the guide pages



GUIDE 127 FLAMMABLE LIQUIDS (WATER-MISCIBLE)

POTENTIAL HAZARDS

FIRE OR EXPLOSION
- HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a (P) may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.

HEALTH
- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control may cause pollution.

PUBLIC SAFETY
- CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.
- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind, uphill and/or upstream.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING
- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION
Large Spill
- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire
- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

In Canada, an Emergency Response Assistance Plan (ERAP) may be required for this product. Please consult the shipping document and/or the ERAP Program Section (page 391).

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FLAMMABLE LIQUIDS (WATER-MISCIBLE) GUIDE 127

EMERGENCY RESPONSE

FIRE
CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.
CAUTION: For fire involving UN1170, UN1987 or UN3475, alcohol-resistant foam should be used.
Small Fire
- Dry chemical, CO_2, water spray or alcohol-resistant foam.

Large Fire
- Water spray, fog or alcohol-resistant foam.
- Do not use straight streams.
- Move containers from fire area if you can do it without risk.

Fire involving Tanks or Car/Trailer Loads
- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

SPILL OR LEAK
- ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor-suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean, non-sparking tools to collect absorbed material.

Large Spill
- Dike far ahead of liquid spill for later disposal.
- Water spray may reduce vapor, but may not prevent ignition in closed spaces.

FIRST AID
- Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.
- Move victim to fresh air.
- Call 911 or emergency medical service.
- Give artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- Wash skin with soap and water.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
- Keep victim calm and warm.

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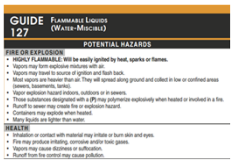
Potential Hazard Section

- This section includes two types of hazards
  - Fire or explosion
  - Health
- The hazard most associated with the material is listed first
- The material can have both hazards associated with the chemical



GUIDE 127 FLAMMABLE LIQUIDS (WATER-MISCIBLE)

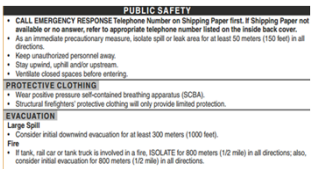
POTENTIAL HAZARDS

FIRE OR EXPLOSION
- HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and flash back.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors or in sewers.
- Those substances designated with a (P) may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.

HEALTH
- Inhalation or contact with material may irritate or burn skin and eyes.
- Fire may produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control may cause pollution.

Public Safety Section

- This section includes:
  - Initial isolation distance
  - Protective clothing recommendations
  - Evacuation distances



PUBLIC SAFETY
- CALL EMERGENCY RESPONSE Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.
- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind, uphill and/or upstream.
- Ventilate closed spaces before entering.

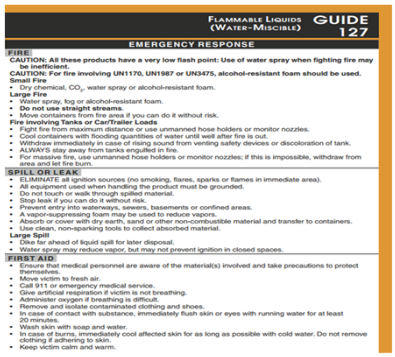
PROTECTIVE CLOTHING
- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

EVACUATION
Large Spill
- Consider initial downwind evacuation for at least 300 meters (1000 feet).

Fire
- If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

Emergency Response Section

- This section identifies what to do in the event of a fire, spill, or leak and outlines general first aid procedures



FLAMMABLE LIQUIDS (WATER-MISCIBLE) GUIDE 127

EMERGENCY RESPONSE

FIRE

CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.
CAUTION: For fire involving UN1170, UN1987 or UN3475, alcohol-resistant foam should be used.
Small Fire
- Dry chemical, CO_2, water spray or alcohol-resistant foam.

Large Fire
- Water spray, fog or alcohol-resistant foam.
- **Do not use straight streams.**
- Move containers from fire area if you can do it without risk.

Fire involving Tanks or Car/Trailer Loads
- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
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- Wash skin with soap and water.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
- Keep victim calm and warm.

Green Section – Table 1

- This section contains a table that lists toxic inhalation hazard (TIH) materials by ID number
  - Including certain chemical warfare agents and water-reactive materials that produce toxic gases upon contact with water
- The green section should be consulted immediately for any entries highlighted in green in the yellow or blue sections

Green Section – Table 1

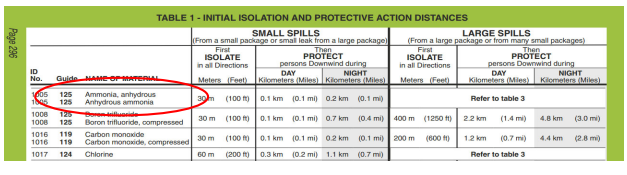

TABLE 1 - INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

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ID No.	Guide	NAME OF MATERIAL	SMALL SPILLS (From a small package or small leak from a large package) First ISOLATE in all Directions Meters (Feet)	Then PROTECT persons Downwind during DAY Kilometers (Miles)	Then PROTECT persons Downwind during NIGHT Kilometers (Miles)	LARGE SPILLS (From a large package or from many small packages) First ISOLATE in all Directions Meters (Feet)	Then PROTECT persons Downwind during DAY Kilometers (Miles)	Then PROTECT persons Downwind during NIGHT Kilometers (Miles)
1005	125	Ammonia, anhydrous	30 m (100 ft)	0.1 km (0.1 mi)	0.2 km (0.1 mi)	Refer to table 3		
1005	125	Anhydrous ammonia						
1008	125	Boron trifluoride	30 m (100 ft)	0.1 km (0.1 mi)	0.7 km (0.4 mi)	400 m (1250 ft)	2.2 km (1.4 mi)	4.8 km (3.0 mi)
1008	125	Boron trifluoride, compressed						
1016	119	Carbon monoxide	30 m (100 ft)	0.1 km (0.1 mi)	0.2 km (0.1 mi)	200 m (600 ft)	1.2 km (0.7 mi)	4.4 km (2.8 mi)
1016	119	Carbon monoxide, compressed						
1017	124	Chlorine	60 m (200 ft)	0.3 km (0.2 mi)	1.1 km (0.7 mi)	Refer to table 3		

Green Section – Table 2

- Table 2 lists materials that produce large amounts of toxic inhalation hazard (TIH – PIH in the U.S.) gases when spilled in water and identifies the TIH gases produced
- These water-reactive materials are easily identified in Table 1 because their names are immediately followed by "**(when spilled in water)**"

TABLE 2 - WATER-REACTIVE MATERIALS WHICH PRODUCE TOXIC GASES

Materials Which Produce Large Amounts of Toxic-by-Inhalation (TIH) (PIH in the US) Gas(es) *When Spilled in Water*

ID No.	Guide No.	Name of Material	TIH Gas(es) Produced
1162	155	Dimethyldichlorosilane	HCl
1183	139	Ethyldichlorosilane	HCl
1196	155	Ethyltrichlorosilane	HCl
1242	139	Methyldichlorosilane	HCl
1250	155	Methyltrichlorosilane	HCl
1295	139	Trichlorosilane	HCl
1298	155	Trimethylchlorosilane	HCl
1305	155P	Vinyltrichlorosilane	HCl
1305	155P	Vinyltrichlorosilane, stabilized	HCl
1340	139	Phosphorus pentasulfide, free from yellow and white Phosphorus	H_2S
1340	139	Phosphorus pentasulphide, free from yellow and white Phosphorus	H_2S
1360	139	Calcium phosphide	PH_3
1384	135	Sodium dithionite	H_2S SO_2
1384	135	Sodium hydrosulfite	H_2S SO_2
1384	135	Sodium hydrosulphite	H_2S SO_2
1397	139	Aluminum phosphide	PH_3
1419	139	Magnesium aluminum phosphide	PH_3
1432	139	Sodium phosphide	PH_3
1541	155	Acetone cyanohydrin, stabilized	HCN

Green Section – Table 3

- Table 3 lists commonly encountered TIH materials
- The selected materials are:
  - Ammonia, anhydrous (UN1005)
  - Chlorine (UN1017)
  - Ethylene oxide (UN1040)
  - Hydrogen chloride, anhydrous (UN1050) and hydrogen chloride, refrigerated liquid (UN2186)
  - Hydrogen fluoride, anhydrous (UN1052)
  - Sulfur dioxide / sulphur dioxide (UN1079)

Green Section – Table 3

TABLE 3 - INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES FOR LARGE SPILLS FOR DIFFERENT QUANTITIES OF SIX COMMON TIH (PIH in the US) GASES

	First ISOLATE in all Directions		Then **PROTECT** persons Downwind during									
			DAY						NIGHT			
			Low wind (< 6 mph = < 10 km/h)		Moderate wind (6-12 mph = 10 - 20 km/h)		High wind (> 12 mph = > 20 km/h)		Low wind (< 6 mph = < 10 km/h)		Moderate wind (6-12 mph = 10 - 20 km/h)		High wind (> 12 mph = > 20 km/h)	
	Meters	(Feet)	km	(Miles)	km	(Miles)	km	(Miles)	km	(Miles)	km	(Miles)	km	(Miles)
TRANSPORT CONTAINER	**UN1005 Ammonia, anhydrous: Large Spills**													
Rail tank car	300	(1000)	1.7	(1.1)	1.3	(0.8)	1.0	(0.6)	4.3	(2.7)	2.3	(1.4)	1.3	(0.8)
Highway tank truck or trailer	150	(500)	0.9	(0.6)	0.5	(0.3)	0.4	(0.3)	2.0	(1.3)	0.8	(0.5)	0.6	(0.4)
Agricultural nurse tank	60	(200)	0.5	(0.3)	0.3	(0.2)	0.3	(0.2)	1.3	(0.8)	0.3	(0.2)	0.3	(0.2)
Multiple small cylinders	30	(100)	0.3	(0.2)	0.2	(0.1)	0.1	(0.1)	0.7	(0.5)	0.3	(0.2)	0.2	(0.1)

Personal Protective Equipment

PPE

- Protective clothing
  - For chemical exposure hazards
- Protective equipment
  - For chemical and/or physical hazards

Level A

- Level A: fully encapsulated suit & SCBA
  - Maximum respiratory, skin, eye protection
  - Butyl rubber and others

Level B

- Level B: full body suit & SCBA
  - Maximum respiratory & moderate skin protection
  - Neoprene, butyl rubber, PVC

Level C

- Level C: protective suit & APR
  - Moderate respiratory and skin protection

Level D

- Level D: work uniform, eye & head protection
  - Minimum respiratory and skin protection

Protective Clothing Materials

- Tyvek®
  - Dusts, dirt, grease
- Tychem® SL (formerly called Saranex)
  - Coated Tyvek®, better for mild chemicals
- Polyethylene
  - Alternative to Tyvek®
- PVC
  - Rain suits, splash suits
  - Moderate chemicals

Protective Clothing Materials

- Neoprene
  - Acids, caustics, solvents
- Butyl rubber
  - Resists gases, ketones, aldehydes
- Nomex®
  - Flame protection
- Kevlar®
  - Cut protection

Hazard Assessment

- Type of hazard – chemical, physical
- Degree of hazard – severity, concentration
- Duration of exposure – time
- Nature of activity – incidental contact vs. engulfment

Performance Requirements

- Resistance – chemical contaminants
- Strength – resists tears and punctures
- Flexibility – freedom of movement
- Temperature limits – temperature range
- Ability to clean – decon, wash, reuse
- Durability – resists abrasions, fatigue, wearing

Chemical Resistance

- Degradation
  - Chemical attack on the item
- Permeation
  - Chemical movement via concentration gradient
- Penetration
  - Chemical movement through physical opening such as cuts, tears, improper replacement of exhaust valves
- Chemical resistance charts
  - Differs for each manufacturer

Clothing Items

- Disposable
  - Remove and dispose of after each use
- Reusable
  - Must be cleaned and inspected after each use

Clothing Types

- Boots & booties
  - Material composition
  - Steel toe
  - Type of sole
- Suits
  - One-, two-, and three-piece outfits
- Gloves
  - Material composition
  - Inner and outer

Clothing Standards

- ASTM (American Society for Testing & Materials)
  - Head protection
- NFPA (National Fire Protection Association)
  - Chemical protective suits – 1991,1992,1993
- ANSI (American National Standards Institute)
  - Eye protection Z87
  - Head protection Z89

Prior to Use

- Assess hazards and operational requirements
- Properly select equipment
- Plan and prioritize activities
- Anticipate emergencies

During Use

- Conduct periodic integrity checks
- Monitor for heat stress
- Implement safe work activities
- Avoid false sense of security
- Always use within limits

After Use

- Visual check
  - Zippers, exhaust valves, seams, and gloves (if attached)
- Pressure check
  - Following manufacturer guidelines
- Store properly
  - Keep in a cool environment

Head Protection: Hard Hats

- Class G
  - Limited protection (2,200 V)
- Class E
  - High protection (20,000 V)
- Class C
  - No voltage protection

Eye & Face Protection

- Safety glasses (minimum requirement)
- Goggles
  - Protection from chemicals, splashes, dust, or projectiles
- Face shield
  - Protection from splashes or projectiles
- Chemical splash hood
  - Shoulder-length or longer

Hand Protection

- Gloves/sleeves
  - General duty
    - Cotton, leather
  - Sharp objects, cuts
    - Leather, Kevlar®
  - Chemical
    - Multiple types

Foot Protection

- Shoes/boots
  - Steel toe
    - Compression, puncture
  - Composite toe
    - Compression, impact
  - Metatarsal guards
    - Protects top of foot behind toe
  - Chemical resistant
    - Prevents contact with chemicals

Respiratory Protection

Air-Purifying Respirators

- Air-purifying respirator (APR)
  - Particulate filter
  - Gas & vapor filter
  - Combination filter
- Powered air-purifying respirator (PAPR)
  - Belt- or mask-mounted powered filter

Supplied Air Respirators

- Supplied air respirator (SAR)
  - Airline respirator
  - Self-contained breathing apparatus
  - Combination

Respirator Parameters & Requirements

- Protection factor
- Fit test
- Obstruction to a proper face seal
- Written respirator protection program
- Training
- Medical surveillance
- Hazard evaluation & assessment
- Maintenance, inspection & storage
- NIOSH approval
- Safe work practices

Limitations of Air-Purifying Respirators

- Concentration of contaminant
- Oxygen level (19.5% – 23.5%)
- Cartridge useful life
- Chemical warning properties
- Potential for flash fire
- Duration of work
- Proper training / fit test

Limitations of Supplied Air Respirators

- Concentration of contaminant
- Must provide “Grade D” air source
- More cumbersome/unwieldy
- Mobility (airline style)
- Length of work time (SCBA style)
- Length of travel distance (300’ airline)
- Proper training / fit test

Air Monitoring

Purpose of Air Monitoring

- Air monitoring provides critical information necessary for:
  - Selecting proper personal protective equipment
  - Specifying safe work practices
  - Assessing the potential health effects
  - Determining actions to mitigate the hazards
  - Helping to determine work zones and decon, isolation, and evacuation areas

Methods

- Real-time field monitoring
  - Using portable field instruments
- Air sampling
  - Using laboratory analysis

Types of Data

- Qualitative data
  - Identifies hazards that are present
- Quantitative data
  - Specifies the concentration of the hazards
- Combination
  - Most equipment provides both qualitative and quantitative data

Characteristics

- Consider the following characteristics when selecting instruments:
  - Intrinsic or inherent safety – resistance to fire or explosion
  - Useful results – response times
  - Selectivity – identify specific chemicals
  - Sensitivity – lowest concentration
  - Error – accurate/precise
  - Portability – shock, damage, lightweight

Sampling

- Obtain enough samples from different locations to assess the entire site
  - One-time and continuous sampling
- Considerations while sampling:
  - Vapor density
  - Changing environmental conditions
  - Frequency
  - Foot traffic
  - Off-site contributing factors

Safety

Because instruments can be a source of ignition, they must be **inherently safe for use** in flammable and explosive atmospheres.

Combustible Gas Indicators

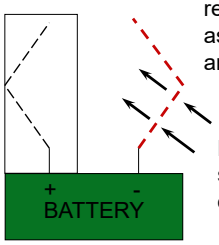
Gastech

MultiRae

How a CGI Works

Wheatstone Bridge Sensor

Control wire resistance unchanged

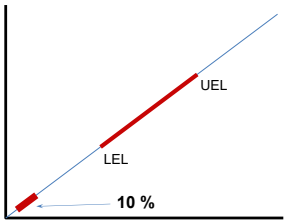


Detector wire resistance increases as sample "burns" and wire heats up

Flammable ATM sample passing over detector

CGI Data Interpretation

Fuel-to-Air Ratio for Flammable Atmospheres



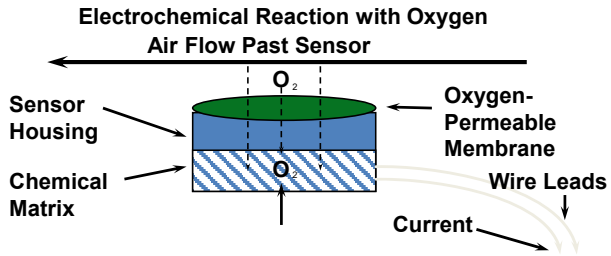
CGI Interferences

- Chlorinated solvents
- Halogens
- Sulfur compounds
- Gasoline
- Acids & bases

Oxygen Meter

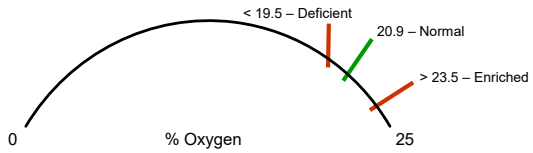
- An oxygen meter measures the amount of oxygen in the atmosphere
- The sensor will read 0% – 25%
- Uses an electrochemical sensor
- Sensor must be replaced every 12 – 18 months, depending on manufacturer

Oxygen Meter



Oxygen Data Interpretation

Oxygen Meters Measure from 0 – 25% Oxygen



Calibration

Air monitoring instruments must be calibrated and bump-tested in accordance with manufacturer specifications.

Colorimetric Tube Systems


Colorimetric Tubes

- Each box contains 10 tubes
- Instructions on back of box
- Arrow indicates direction of insertion and airflow
- Concentration scale and gas type printed on tube
- Number of strokes, total sample volume, and units of measurement also printed on tube

Site Control

Site Control

- The purpose of site control is to reduce or prevent the spread of contamination by establishing artificial and/or physical barriers
- Site control must be site-specific

Site Map

- A site map is essential to site control
  - Access & evacuation routes
  - Areas requiring special PPE
  - Topographic features, climatic conditions, drainage, landmarks
- Maps are ever-changing and are influenced by:
  - Accidents
  - Changes in site activities
  - Emergencies
  - Unanticipated hazards

Site Preparation

- Key focus is worker safety
- Major steps:
  - Construct roadway(s)
  - Arrange traffic flow patterns
  - Eliminate physical hazards (when possible)
  - Install skid-resistant devices as needed
  - *[Continued…]*

Site Preparation

- Construct operation pads for mobile facilities
- Construct loading docks and processing, staging, and decon areas
- Provide illumination as needed
  - Install electrical equipment and connections as needed

Site Zones

- Zones are developed to ensure that:
  - Personnel are protected against hazards specific to where they are working
  - Contamination is confined to designated areas
  - Personnel can be located and evacuated in an emergency

Site Zones

- Exclusion zone / hot zone
  - Encompasses all known or suspected hazardous materials
- Contamination reduction zone / warm zone
  - Between exclusion zone and support zone
  - Contamination reduction corridor is established within this zone
- Support zone / cold zone
  - Area outside contamination reduction zone where equipment and rescue personnel are stationed
- Zones can change at any time during the operation!

Site Zones

- Size and shape of each zone depends on the hazards present:
  - Nature and extent of chemical hazard
  - Features of the site
  - Potential for other accidents to occur
  - Weather conditions
  - Nature of the work
  - Size of contaminated area
  - Off-site hazards

Decontamination

Decontamination

- Goal of decontamination is to reduce contamination to a safe, negligible level
- Indirectly supports the site control objective
- Must be performed on all personnel and equipment
- Last line of defense is washing your hands and face

Sources of Contamination

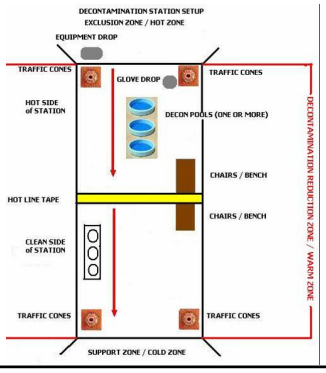
- Direct contamination
  - High-contact surfaces
  - Hands
  - Feet
- Indirect contamination
  - Airborne: gas, vapor, aerosol

Decon Methods

- Physical decon (dry)
  - Remove PPE to prevent cross-contamination
- Chemical decon (wet)
  - Wash with decon solution
- Combination (partial wet)
  - Wash some areas
  - Remove PPE

Decon Planning

- Chemical hazards
- Potential for contamination
- Level of protection
- Number of people
- Location
- Emergencies



Decon Emergencies

- Mild emergency
  - Container spill
  - Minor injury
- Go to decon station and perform decon procedures to exit exclusion zone
  - Decon must be set up at a safe distance from the hazard

Decon Emergencies

- Moderate emergency
  - Large spill
  - Potential for fire
- Personal judgment
  - Go to decon station and quickly decon
  - Bypass decon station and move to a safer distance before removing PPE

Decon Emergencies

- Serious emergency
  - Fire/explosion
  - Large chemical reaction
- Bypass decon station
  - Move to a safer location
  - Stop and remove PPE
  - Leave PPE for later cleanup
  - Wash hands and face as soon as practical

Offensive & Defensive Measures

Hazmat Release Offensive & Defensive Options

- Spills/releases
- Risk assessment
- NFPA definitions
- Defensive control options
- Offensive control options

Offensive Control Options

- Special training and protective equipment is required to safely handle the incident
- A hazmat technician may have to decide on PPE
- Understanding emergency controls and safe work practices during mitigation is necessary for a technician to make critical decisions

Spills/Releases

- Three goals:
  1. Life safety
  2. Protection of the environment
  3. Protection of property

Spills/Releases

- Factors that affect spills:
  - Hazards associated with the material
  - Risk assessment
  - State & quantity of material
  - Company policies
  - Route of dispersion
  - Equipment needs
  - Secondary contamination
  - Weather

NFPA Definitions – Control

"The defensive or offensive procedures, techniques and methods used in the mitigation of a hazardous materials incident, enclosing containment, extinguishment and confinement."

NFPA Definitions – Containment

- "The actions taken to keep a material in its container (i.e., stop a release of the material or reduce the amount being released)"
- Containment actions include:
  - Plugging
  - Overpacking
  - Patching
  - Bypassing

NFPA Definitions – Confinement

- "Those procedures taken to keep a material in a defined or local area once released"
- Confinement procedures include:
  - Secondary containment
  - Overpacking
  - Retaining
  - Damming

Containment Measures

- Diking
- Damming
- Encapsulation
- Burning
- Nets
- Precipitation
- Biodegradation
- Weirs
- Oil control booms
- Skimmers
- Pneumatic barriers
- Spill herding
- Dredging

Incident Command

Legal Requirements

- Legal requirements for incident command:
  - The incident commander (IC) has “overall” responsibility for all actions
  - An IC MUST be established per federal & state regulations
  - Certain environmental regulations stipulate that an Incident Command System (ICS) be established to oversee incident management:
    - CGC 8670, Department of Fish & Game
    - Oil Spill Prevention & Response (OSPR)
  - *[Continued…]*

Legal Requirements

- Single command
- Unified command
- Duration of command:
  - ICS will be operational as long as the emergency response operations subject to the HAZWOPER rule are in effect

Designated Responsibilities

- Designated responsibilities of incident command:
  - Manage affected populations
  - Order appropriate response resources
  - Establish the ICS for incident management
  - Facilitate appropriate ICS functions
  - Ensure appropriate liaison with affected entities
  - Ensure safety management & information / public relations
  - Provide appropriate information through notifications to concerned governmental agencies, executive management, etc.

Incident Action Plan

- Incident Action Plan (IAP)
  - “Strategic” document
  - Outlines objectives and management goals
  - Identifies the incident’s:
    - Organization
    - Resources
    - Assignments

Site Safety Plan

- Site Safety Plan (SSP):
  - “Tactical” document
  - Details & specifies methods for mitigation to accomplish incident objectives
  - Requires the technical input of trained individuals to prepare

Incident Command Positions

- Incident commander & safety officer/official are MANDATORY to organize & support initial incident response
- OSHA minimum response organization (a very minimum organization by many standards):
  - IC/SO
  - Two-person buddy system for entry
  - Two-person minimum backup team
  - Entry team leader/observer

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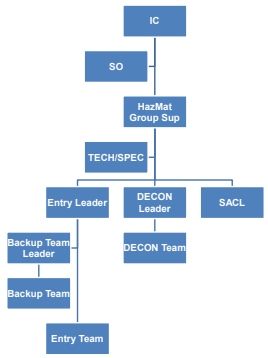
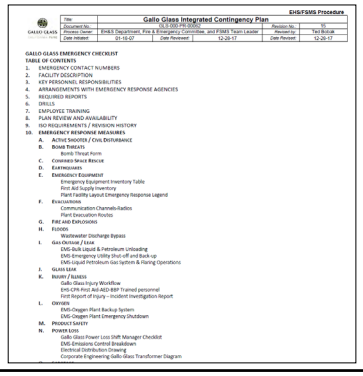


Large-Incident Transition of Command

- As the incident becomes sophisticated, section chiefs (SCs) will be added to the organization:
  - SCs are responsible for ICS “general staff” functions
  - The functions are:
    - Operations
    - Planning/intelligence
    - Logistics
    - Finance/administration

Large-Incident Transition of Command

- The hazardous materials group works under the operations section chief at this level
- At the level of sophistication, additional officers are also needed to support the IC:
  - Safety officer
  - Liaison officer
  - Information officer
  - Counsel / legal affairs



EHS/FSMS Procedure

Gallo Glass Integrated Contingency Plan

Title:	Gallo Glass Integrated Contingency Plan				
Document No.:	GLS-000-PRI-00002			Revision No.:	01
Process Owner:	EH&S Department, Fire & Emergency Committee, and FSMS Team Leader			Revision by:	Ted Bunde
Date Initiated:	01-16-07	Date Reviewed:	12-20-17	Date Revised:	12-20-17

GALLO GLASS EMERGENCY CHECKLIST

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Termination Procedures

Incident Termination

The larger the incident and the more players involved, the more important it is that the emergency be brought to a proper conclusion.

Incident Termination

- Why incident termination procedures are used:
  - Ensures proper personnel safety
  - Lessons learned are shared
  - Required by law
- Termination consists of:
  - Debriefing
  - Post-incident analysis
  - Critique

Failure to Properly Terminate the Incident

- Termination activities are limited in scope to those directly involved in the incident – not the whole world!
- Incorrect hazard data could result in:
  - Illness to those exposed
  - Improper cleanup techniques
  - Unsafe disposal procedures
  - Inaccurate assessments from the public and news media

Debriefing Focus

Focus on the emergency response team.

Debriefing Topics

- Provides health information
- Reviews equipment and apparatus exposure
- Provides follow-up contact person
- Identifies problems requiring immediate action
- Says “thank you”

Debriefing Goals

- Let employees know what they’ve been exposed to, if anything
- Identify equipment damage or unsafe conditions
- Determine responsibility for data collection regarding the incident
- Summarize division/group/sector activities
- Reinforce what went well

Debriefing Scheduling

- The debriefing should occur at demobilization as soon as the emergency operation is completed
  - Ideally this should be before first responders leave the scene
- Debriefings should be conducted by one person and be limited to 45 minutes in duration

Debriefing Participants

- Initial responders
- Hazmat response team
- Decontamination team
- EMS workers
- Command staff
- General staff
- Division/group supervisors
- debriefing
- Agency representatives
- Other key players as specified by the Incident Commander
- Off-site communications personnel should be included in this phase
  - May require a separate debriefing

Debriefing Location

- Debriefings should be conducted in buildings or vehicles that are free from distractions such as:
  - Cold or hot weather
  - Emergency service radios
  - Loud generators

Post-Incident Analysis

- Post-incident analysis (PIA) activities should be assigned to a member of the command staff
- PIA is a reconstruction of the incident to establish a clear picture of the events that took place during the incident and should be started as soon as possible after the emergency phase of the incident
- A brief chorological review of who, what, where, and when should be outlined

Incident Critique

- The Final Rule of 29 CFR 1910 mandates critiques for hazardous materials incidents
- The Incident Commander has the direct responsibility to schedule and organize the critique
- Critiques should be held after the incident has been completely terminated and information has been gathered and analyzed

Critique Function

- Improves efficiency
- Pinpoints weaknesses – not of the workers, but of the implementation of the program during the emergency response


Thank You
Questions? Contact us at:
NES, Inc.
1141 Sibley Street
Folsom, CA 95630
NES
NESglobal.net
916-353-2360
800-637-2384

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First Responder Operations Level

Introduction

This course presents training intended to familiarize emergency response members with the general principles of emergency response operations and the procedures to be followed in the event of a hazardous material incident. Responding to chemical spills and accidental releases of hazardous substances may be dangerous. The various levels of training correlate to the duties and function to be performed by the responder. Employees who participate, or who are expected to participate, in emergency response must be given training in accordance with the regulations.

HAZWOPER

The OSHA Hazardous Waste and Emergency Response Operations Standard (29 CFR 1910.120) & (8 CCR 5192) requires training which will provide employees with the knowledge and skills necessary to safely perform emergency response actions. OSHA has provided tiered training criteria for those employees who may be designated as members of an emergency response team.

First responder operations level: First responders at the operational level shall have received at least eight hours of training or have had sufficient experience to objectively demonstrate competency in containing the release from a safe distance, keep it from spreading, and prevent exposures. First responders trained to the Operations Level also assume the role of Awareness Level.

Definitions of First Responders Awareness and Operations levels:

- First Responder “Awareness“ Level: One likely to witness or discover a Hazardous Material release and who can initiate a response by notifying authorities*, taking no further actions.* 29 CFR 1910.120(q)(6)(i), Title 8 CCR 5192(q)(6)(A).
- First Responder “Operations” Level: One who responds to Hazardous Material releases for purpose of protecting nearby persons, environment or property — *trained in a defensive fashion without trying to stop the release*. 29 CFR 1910.120(q)(6)(ii), Title 8 CCR 5192(q)(6)(B).

Emergency Response Plan

An emergency response plan shall be developed and implemented by all employers within the scope of subsections 5192 (a)(1)(A)-(B) of this section to handle anticipated emergencies prior to the commencement of hazardous waste operations. The plan shall be in writing and available for inspection and copying by employees, their representatives, division personnel, and other governmental agencies with relevant responsibilities.

Elements of an Emergency Response Plan

The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following:

1. Pre-emergency planning.
2. Personnel roles, lines of authority, and communication.
3. Emergency recognition and prevention.
4. Safe distances and places of refuge.
5. Site security and control.
6. Evacuation routes and procedures.
7. Decontamination procedures which are not covered by the site safety and health plan.
8. Emergency medical treatment and first aid.
9. Emergency alerting and response procedures.
10. Critique of response and follow-up.
11. Personal protective equipment (PPE) and emergency equipment.

FRO Roles and Responsibilities

First responders at the operations level are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. **FRO members are trained to respond in a defensive fashion without actually trying to stop the release.** Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposures. First responders at the operational level shall have received at least eight hours of training or have had sufficient experience to objectively demonstrate competency in the following areas in addition to those listed for the awareness level; and the employer shall so certify:

1. Knowledge of the basic hazard and risk assessment techniques.
2. Know how to select and use proper PPE provided to the first responder operational level.
3. An understanding of basic hazardous materials terms.
4. Know how to perform basic control, containment, and/or confinement operations and rescue injured or contaminated persons within the capabilities of the resources and PPE available with their unit.
5. Know how to implement basic equipment, victim, and rescue personnel decontamination procedures.
6. An understanding of the relevant standard operating procedures and termination procedures.

Medical Surveillance

Employers and employees engaged in operations specified in the HAZWOPER Regulation shall institute a medical surveillance program. The medical surveillance program shall be instituted by the employer for the following employees:

1. Any employee who is or may be exposed to hazardous substances or health hazards at or above the PELs or, if there is no PEL, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year.

2. Any employee who wears a respirator during any part of a day for a period of 30 days or more in a year, or as required by 8 CCR 5144.
3. Any employee who is injured, becomes ill or develops signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and
4. Members of HAZMAT teams.

Medical examinations and consultations shall also be made available by the employer to each employee covered under the regulation on the following schedules:

1. Prior to assignment.
2. At least once every twelve months for each employee covered, unless the attending physician believes a longer interval (not greater than biennially) is appropriate.
3. At termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last six months.
4. As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards or that the employee has been injured or exposed above the PELs or published exposure levels in an emergency situation.
5. At more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary

First On-Scene Actions

The person who discovers an incident is considered the "first on-scene". First on-scene actions are similar to first responder actions. Critical actions include safely approaching the area or safely evacuating the area, calling for help, warning others, and isolating the area. In addition, because of first-hand knowledge, the initial person on scene may provide important information to response personnel. A chemical incident becomes an emergency response at the time it is discovered. The actions taken by this person are intended to protect personal safety, isolate the area and make notification to the proper authorities. Safety of the first on-scene and all other employees is the goal of the entire response during an incident.

The first operational priority = Safety, Isolate, Notification and deny entry! All Haz Mat responders should "SIN" as the basic initial on–scene actions at all Hazardous Material incidents.

The first operational *thought* for everyone = Safety!

- Do not unnecessarily expose yourself or others.
- Avoid contact with the liquid, vapors, gases, etc.
- Avoid areas with odors.
- Stay upwind, upgrade & uphill and at a safe distance.
- Do not enter a spill area if safety is compromised.
- Do not rescue someone unless personal safety can be maintained.

The first operational priority = Isolate and deny entry!

- Responders can safely attempt to isolate and deny entry by establishing Perimeters & Control Zones via ERG.

- The dilemma of distance in safety vs. isolation (distance is safety's #1 ally, while it is isolation's #1 enemy)

Perimeter Control Objectives

- Control "Entry Points" (secure doors, stairways, gates, intersections, on and off ramps, etc.).
- Control "Perimeter" between all Entry Points.
- Control "Access" inside Perimeter (incl. responders).

Perimeter Control Tactics

- Determine size and extent of perimeter (per ERG, downwind perimeter will usually be longer).
- Identify all entry points.
- Control all entry points.

Identify and establish boundaries for perimeter

- Unstaffed barricades usually ineffective.
- Be aware of ignition sources from vehicles.
- Use existing barriers.

Control access to the perimeter

- Deny entry to all unauthorized personnel (incl. responders).
- Stage all responders without an immediate mission.
- Establish emergency exit procedures for all responders.
- Hazardous Material Groups will establish Control Zones.
- Watch out for wind shifts.
- IC ultimately responsible for Perimeters and Control Zones (may need tactical plans and pre-arranged logistics to manage this).

The First Operational Alert — Notification

Three types of "Notifications" to alert others of a Haz Mat event

- "Mandatory" Notifications
- "Resource" requests
- "Report of Conditions"

Responsible Party must notify authorities of a Hazardous Materials release or potential release.

Criminal penalties are possible for non-notification.

Mandatory notifications

- Local dispatch (Local 911).
- CUPA/Local Administering Agency (#:_____).
- State Warning Center (800-852-7550).
- National Response Center (800-424-8802).

Other notifications per specific incident

- Pesticide spill – County Agriculture.
- Spill in state waters – Cal OES.
- Spill on state highway/freeway (incl. county roads) – California Highway Patrol (CHP).
- Radiological release – Department of Homeland Security (DHS) (Radiological Branch).

- Release impacting state wildlife – Department of Fish and Wildlife (DFW).
- Acutely hazardous material within 1/2 mile of school – School District Superintendent.

General information needed for mandatory notifications

- Name/Agency of person reporting.
- Location of Hazardous Materials release.
- Haz Mat involved.
- Nature of problem.
- Quantity released.
- Potential hazards, etc.

Chemical Hazards

Introduction

Many chemicals will present more than one type of hazard; toxicity, fire, explosion, etc. Chemicals may be nontoxic under normal conditions; however, when heated they form highly toxic by-products. In addition, some toxic chemicals may be colorless and odorless, may dull the sense of smell, or may have no warning properties. Preventing exposure to toxic chemicals is a primary concern; therefore, it is necessary to obtain all available information relative to a chemical in order to evaluate the potential hazards and ascertain the appropriate control measures. **DO NOT assume that chemicals will react in the same manner based on similar chemical names or physical state**. The difference in a single letter between two chemical names may identify two entirely different chemicals with completely different characteristics.

Under specific circumstances, a substance's chemical hazard(s) may pose a more immediate and/or serious hazard to an individual than from its toxic properties. The ability to identify chemical hazard properties of substances is the basis for determining safe handling and chemical exposure prevention procedures for individual materials. Categorizing chemical materials by their chemical hazards (hazard categorization) organizes and simplifies field handling and reduces the likelihood of chemical injury or exposure.

Chemical & Physical Properties

Chemical compounds have specific properties which determine the type and degree of hazard they represent. Evaluating their potential hazard depends on understanding their properties and their relationship to the environment. Some of these properties can be divided into two categories. These are chemical properties and physical properties

Chemical properties are

- Corrosivity
- Toxicity
- Oxidizing potential
- Reactivity

Physical properties are

Solubility: The ability of one chemical to blend uniformly with another.

Density: Weight/Mass per unit volume. Applies to Liquids and Solids

Specific Gravity: Ratio of the density of a substance to the density of water.
Water = 1 < 1 = Float > 1 = Sink

Boiling Point: Temperature at which a liquid changes to a vapor.

Melting Point: Temperature at which a solid changes to a liquid

Vapor Density: Ratio of the density of a gas or vapor to the density of ambient air.
Air = 1 < 1 = Rise > 1 = Settle

Vapor Pressure: The pressure of a material exerted against the atmosphere. VP refers to the ability of a substance to evaporate.

Flash Point: The minimum temperature at which a substance (liquid) produces sufficient flammable vapors to support combustion

Flammable/Explosive Limits: Range of flammable vapor (fuel) concentration in air producing an ignitable atmosphere

Auto Ignition Temperature: Temperature at which ignition occurs without a source of ignition. Expressed in mm/Hg.

Corrosiveness: The ability of a substance to cause corrosion (destruction of metals and biological tissue).

Sublimation: Temperature at which a solid changes to a gas.

DOT/UN HAZARD CLASSES (HMTUSA)

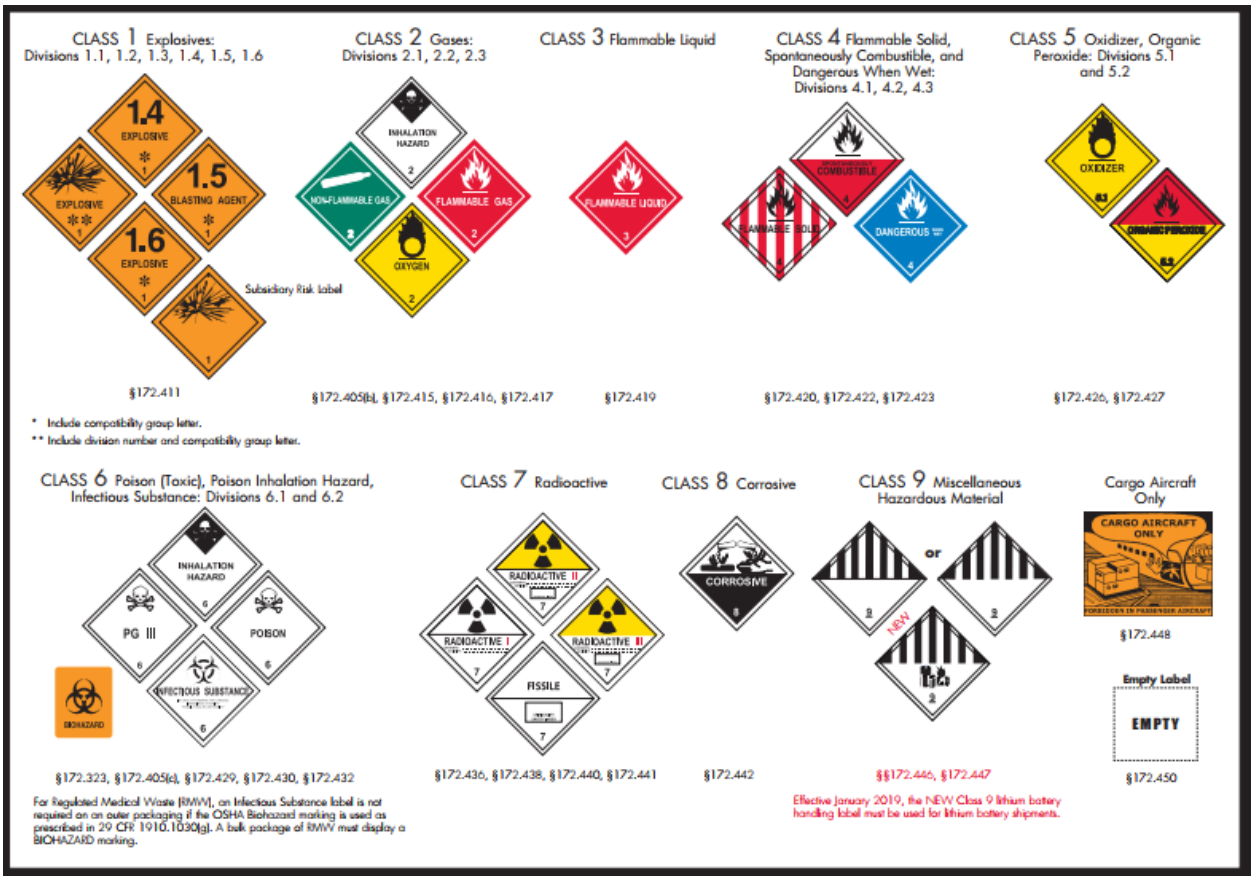
DOT uses placards and labels to help visually identify materials and their hazards. Labels and placards will give us information in 4 ways.

Color: The colors are specific to the hazards and help to identify the DOT listed hazard.

Symbol: The symbol that is located at the top of the placard and many labels gives valuable information regarding the DOT listed hazard.

Wording/ID Number: The word(s) listed in the middle of the diamond or the chemicals specific 4-digit ID Number.

Hazard Class Number: The number located at the bottom of the placard/label. This number is typically a single digit number ranging from one to nine.



Chemical & Reactive Hazards

Under specific circumstances, a substance's chemical Incompatible chemicals will react upon contact. Incompatibility does not necessarily indicate a serious hazard, but many mixtures of incompatible chemicals will react violently. The ability to identify incompatible chemicals is the basis for establishing proper chemical handling procedures.

Reaction of two or more incompatible chemicals (including with water or air) may cause any of the following:

- Generation of Heat.
- Fire.
- Explosion.
- Toxic Gas.
- Formation of shock or friction sensitive compounds.
- Formation of a toxic by-product.
- Separation: To establish or provide a physical barrier (or distance) between segregated hazardous chemicals.
- Segregation: To place chemicals into distinct groups based on their hazardous properties (i.e. categories).

CAUTION Chemicals in the same general hazard category may be incompatible. Examples are Flammable and Oxidizing compressed gasses, Hydrochloric and Sulfuric Acids.

Toxicology

Introduction

Toxicology is the study of adverse health effects caused by exposure to chemical substances and resultant interaction with the human body.

Principles of Toxicology

Routes of entry: Inhalation, Absorption, Ingestion, and Injection.

Mode of action: Physical, Chemical, and Physiological.

Types of exposure: Acute (short duration, high concentration) and Chronic (extended, low concentration).

Degree of Toxic Exposure

- Type and concentration of chemical.
- Duration of exposure
- Frequency and route of exposure
- Route of Entry

Measurements of Toxicity

- Identifying dose threshold for adverse health effects on different living systems. Sources of information—Human studies, Epidemiological studies and Animal studies.
- **Dose-Response relationship**: Comparison of an organism's (human, rabbit, rat, etc.) response to a given material at specific doses (amount of exposure).
- **LD_{50}/LC_{50}**: LD means lethal dose, and the subscript 50 means that the dose was acutely lethal for 50 percent of the animals to whom the chemical was administered under controlled laboratory conditions.

Lethal Dose 50% (LD_{50})

- The concentration of an inhaled substance which results in death of 50% of the test population in a specific time period (usually 1 hour).
- LC_{50} are expressed in terms of parts per million for gases and vapors, and milligrams per cubic meter (mg/m3) for dust and mists.

Lethal Concentration 50% (LC_{50})

- The concentration of an ingested, absorbed, or injected substance which results in the death of 50% of test population.
- One kilogram (kg) equals 2.2 lb.
- The lower the dose, the more toxic the substance.

Exposure Limits

Regulations

(I) Permissible Exposure Limit (PEL): Regulated by OSHA and sets exposure limits for a time weighted average (TWA) typically an 8 hour day or 40 hour work week

(II) Short Term Exposure Limits (STEL): Regulated by OSHA and sets 15 minute exposure limits 4 times a day with a 1 hour break between exposures. (NOTE: CCR Title 8 section 5155)

Guidelines

(III) Recommended Exposure Limit (REL): Recommendations the National Institute for Occupational Safety and Health (NIOSH) provides up to 10 hour TWA 40 hour week.

(IV) Immediately Dangerous to Life or Health (IDLH): Established by NIOSH as an atmosphere that poses an immediate threat to life and health; an exposure that causes irreversible or delayed adverse health effects; and/or an atmosphere that inhibits escape from a dangerous environment.

(V) Threshold Limit Value (TLV): Regulated by American Conference of Governmental Industrial Hygienists (ACGIH) 8 hour TWA 40 hour week

(VI) Workplace Environmental Exposure Level (WEEL): Regulated by (American Industrial Hygiene Association) AIHA 8 hour TWA 40 hour week

(VII) New Chemical Exposure Limits (NCELs): Regulated by the EPA under the Toxic Substances Control Act (TSCA) 8 hour TWA 40 hour week

Factors Influencing Toxicity

Chemical, Exposure, Health, Age, Sex, Genetics, Environmental.

Distribution, Biotransformation and Elimination.

- Routes of entry: Inhalation, Absorption, Ingestion, Injection.
- Distribution mechanisms: Blood, Lymph, Mucous.
- Biotransformation: Metabolism/Detoxification
- Routes of elimination: Exhalation, Perspiration, Excretion, Expulsion.
- Hazards: Bioaccumulation

Types of Toxins

- **Respiratory**: Asphyxiants/Irritants
- **Systemic:** Target specific organ(s)/systems in the body
- **External:** Targets the skin and eyes
- **Special:** Carcinogens, Mutagens, Teratogens, Reproductive

Respiratory Toxins

Simple Asphyxiants: Displaces the oxygen in the atmosphere and can create an oxygen deficient atmosphere < 19.5% or an Oxygen IDLH atmosphere < 16%

Chemical Asphyxiants: Prevents the hemoglobin in the red blood cells from being able to transport oxygen from the lungs to the body's tissues. They are also chemicals that disable the biochemistry of cellular respiration even in the presence of adequate oxygen levels in the blood.

Upper Respiratory Irritant: These chemicals are usually water soluble meaning they irritate the upper airway when they come into contact with the moisture of our respiratory system. The chemical usually displays corrosive properties

Lower Respiratory Irritant: These chemicals are usually not water soluble and do not break down as easily. For this reason the chemical travels deep into the lungs and affects the alveoli. It is here where oxygen exchanges with the red blood cells. When the chemical reaches this point, it creates scar tissue and prevents the blood from receiving oxygen.

Special Toxins

Carcinogens: Cancer causing chemical. Leads to uncontrolled cell growth.

Mutagens: An agent, such as radiation, a chemical substance and some viruses, that causes genetic mutation. It is a substance that is capable of mutating DNA.

Teratogens: Affects developing fetus. The fetus will usually survive birth but is most likely to be born with birth defects.

Reproductive hazards: Substances or agents that may affect the reproductive health of women or men or the ability of couples to have healthy children. These hazards may cause problems such as infertility, miscarriage, and birth defects.

Hazard Assessment

Introduction

Hazard Assessment is a dynamic process initiated during the planning stages of an activity and continued throughout the operation. The process is repeated to assure those involved in an activity know that no new hazards have occurred, existing hazards have not changed in character, or new hazards have been recognized and evaluated before causing harm.

Hazard vs. Risk

The hazard associated with a material or operation describes the degree of harm which may be realized if the hazard occurs. Thus a highly flammable material is more likely to ignite and explode as a result of contact with a source of ignition than a combustible material.

A **hazard** is a potential to do harm. Hazards may be thought of as inherent properties, and risks as potentially changing descriptions of the environment associated with the hazard. Proper hazard assessment for an operation or activity requires that all existing and potential hazards be identified and that the risks (likelihood to cause harm) associated with the hazards be continually evaluated to assure that steps are taken to control or prevent exposure to such hazards.

Risk, however, describes the likelihood that a particular hazard may do harm. Thus a highly flammable material stored in an inert atmosphere away from any sources of ignition is a lower risk to personnel working with the material than the same substance stored in a confined area, adjacent to operating equipment.

Hazard Assessment Process

The process begins with an off-site evaluation which is updated following a site reconnaissance and on-site survey. Combined, these steps constitute site characterization, providing the information needed to identify hazards, and select control measures including personal protective equipment. The information collected during each step of the site characterization process should be used to establish the safety requirements for the next activity.

Steps in Hazard Assessment

Recognition: All existing and potentially new hazards must be identified. This requires anticipating new hazards arising from the interaction of existing hazards, the environment (ambient conditions), physical surroundings and the operation to be performed. Visual observations, instrument measurements, sampling data, previous knowledge and experience, documentation and other sources of information all help to identify actual and anticipated hazards.

Evaluation: After the hazards have been identified, they are *measured* to determine individual and aggregate severity. Chemical hazards, such as flammability, toxic concentration, and oxygen deficiency, may be measured by field monitoring and/or air sampling methods. Some physical hazards including thermal stress, noise and ionizing and non-ionizing radiation may also be measured by instrumentation. Other physical hazards including *slip-trip-fall*, poor visibility, traffic, etc., and most biological hazards are *measured* by thorough observation and study.

Comparison: Once the hazards have been measured, each *measured* value (ppm, mg/m3, % O2, % LEL, dB, etc.), is compacted to an appropriate limit, standard, regulation or guideline. Comparing each hazard to its corresponding safety guidelines and/or regulation will determine which hazards exceed such limits. Standards used for comparison may specify *numbered* values not to exceed (ppm concentration for a chemical contaminant) or conditions not to result in an exposure (trench or excavation resulting in collapse).

Prioritizing: Comparison of the hazards to appropriate safety standards allow for the grouping of such hazards into three primary categories: low risk (i.e. hazard measured far below standard), intermediate risk (i.e. measured value slightly below to slightly above standard), and high risk. Hazards can be ordered according to their risks. The ordering of individual hazards, the environment, physical surroundings, work operations and control measures can then be implemented. The most obvious hazard may not be the hazard most likely to result in harm.

Control: The final step in hazard assessment is to identify the hazard control measures to be utilized. Control measures include engineering (i.e. ventilation), administrative (modified work shift), and

personal protective clothing controls. Control measures are selected based on the type and severity of hazards present, interaction between the hazard's type, and duration of work and site conditions.

Re-evaluation:- Once the above steps have been completed re-evaluation must take place. This is done to see if anything has changed because of action that have been taken or not taken. This is a very important step in a hazardous material response.

Site Characterization

Site Operations Characterization always involves hazard identification and evaluation.

Off-Site

Prior to the beginning of any emergency response specific information should be collected and assessed. As much data as possible should be collected prior to site activities to improve the level of preparation and hazard control.

On-Site

A site reconnaissance would be performed at a safe distance from any present or suspected hazards (on-site but outside the hot zone) prior to the commencement of response activity into the contaminated or hazardous location. The purpose of the on-site reconnaissance is to update the IC or plant supervisor of current conditions. Reconnaissance, by definition, recognizes the limitations to initiating a hazard assessment off-site.

OSHA Hazard Warning System

OSHA 29 CFR 1910.1200

The hazard warning system provides workers the right-to-know concerning the hazards and the identities of the chemicals they are, or may have the potential to be, exposed to in the workplace.

- Effective May 23, 1988, OSHA regulations require that employees be made aware of hazardous substances in the workplace.
- In general, each employee should be apprised of the hazardous properties of chemicals that they may encounter along with measures to take to protect themselves from these chemicals.
- The standard requires that employers inventory all hazardous chemicals in the workplace and include that inventory as a part of the written hazard communication program.
- This inventory will eventually serve as a master list for which a MSDS/SDS must be obtained and maintained.

Employee training shall include:

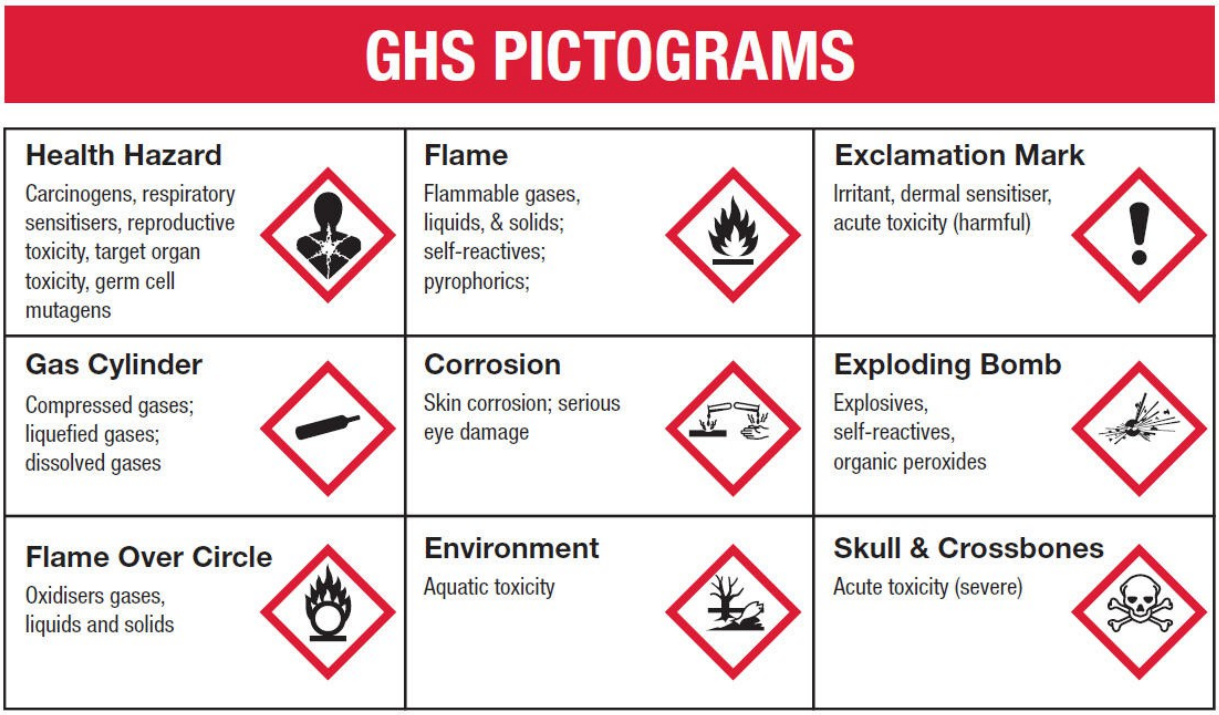
- How to detect presence & release.
- Physical and health hazards.
- Measures to protect themselves.
- Details of HCS program.
- This training shall be conducted with the first 30 days of employment.

Globally Harmonized System (GHS)

The Harmonized system for hazard communication includes the appropriate labeling tools to convey information about each of the hazard classes and categories in the GHS. The use of symbols, signal words or hazard statements other than those which have been assigned to each of the GHS hazard classes and categories, would be contrary to harmonization. The signal word indicates the relative degree of severity a hazard. The signal words used in the GHS are:

- "Danger" for the more severe hazards, and
- "Warning" for the less severe hazards

Signal words are standardized and assigned to the hazard categories within endpoints. Some lower level hazard categories do not use signal words. Only one signal word corresponding to the class of the most severe hazard should be used on a label.



Safety Data Sheets (SDSs)

The Hazard Communication Standard (HCS)(29 CFR 1910.1200(g)), revised in 2012, requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSs) (formerly MSDSs or Material Safety Data Sheets) for each hazardous chemical to downstream users to communicate information on these hazards. The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format.

An SDS should be produced for all substances and mixtures which meet the GHS criteria for physical, health or environmental hazards.

- Section 1: Identification of the substance or mixture, and of the supplier

- Section 2: Hazard(s) Identification
- Section 3: Composition/ information ingredients
- Section 4: First Aid Measures
- Section 5: Firefighting Measures
- Section 6: Accidental Release Measures
- Section 7: Handling and Storage
- Section 8: Exposure Controls / Personal Protection
- Section 9: Physical and Chemical Properties
- Section 10: Stability and Reactivity
- Section 11: Toxicological Information
- Section 12: Ecological Information
- Section 13: Disposal Considerations
- Section 14: Transport Information
- Section 15: Regulatory Information
- Section 16: Other information including preparation and revision of the SDS

Shipping Papers

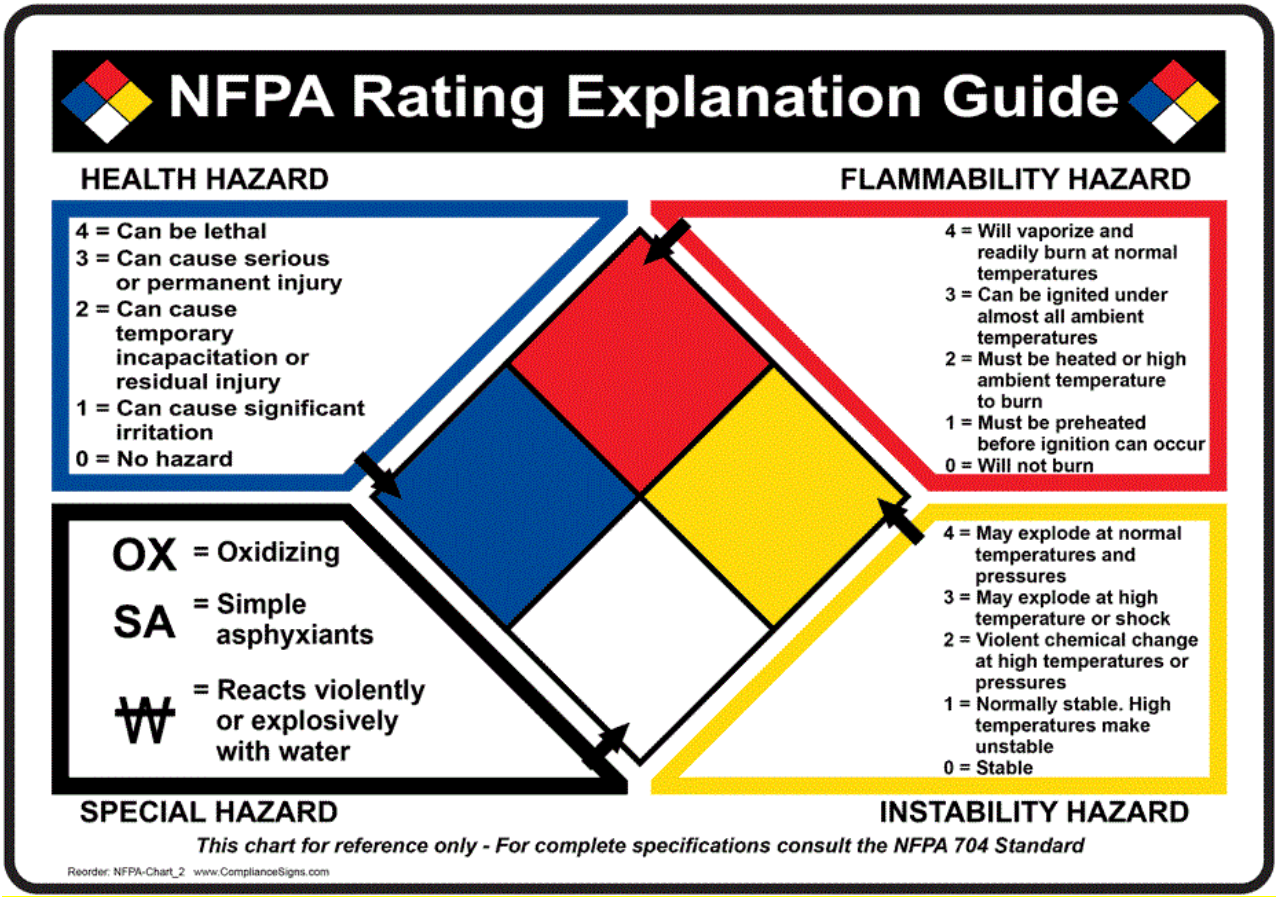
Paperwork need to accommodate the transportation of hazardous materials. Different forms of paperwork are:

- Highway Transportation – Bill of Lading, Shipping Papers, Hazardous Waste Manifest
- Rail Transportation– Waybill & Consist
- Water Transportation – Dangerous Cargo Manifest
- Air Transportation – Airbill

NFPA 704 System

NFPA 704 is a standard maintained by the National Fire Protection Association that presents a simple, readily recognized, and easily understood system of markings, referred to as the 'Fire Diamond', that provides an immediate general sense of the hazards of a material and the severity of these hazards as they relate to emergency response.

NFPA 704 provides criteria for assessing the health, flammability instability, and related hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. A number rating system of 0 to 4 is provided to rate each of the four hazards and is placed on a placard. This placard provides emergency responders with the information they need to determine the immediate actions to be taken in an emergency. Tables in the standard provide the criteria for the ratings and placard specifications such as letter size and arrangement of numbers and colors that are provided in the standard.



Emergency Response Guidebook (ERG)

The 2016 Emergency Response Guidebook (ERG 2016) was developed jointly, for use by firefighters, police, and other emergency services personnel who may be the first to arrive at the scene of a transportation incident involving dangerous goods. It is primarily a guide to aid first responders in quickly identifying the specific or generic hazards of the material(s) involved in the incident, and protecting themselves and the general public during the initial response phase of the incident. For the purposes of this guidebook, the “initial response phase” is that period following arrival at the scene of an incident during which the presence and/or identification of dangerous goods is confirmed, protective actions and area securement are initiated, and assistance of qualified personnel is requested. It is not intended to provide information on the physical or chemical properties of dangerous goods.

After obtaining the identification number consult the North American Emergency Response Guide Book:

- The white pages tell how to use the book plus placard and container identification.
- The yellow pages list the materials in numerical order by UN ID number.
- The blue pages list the materials in alphabetical order.
- The orange bordered pages list 174 individual guide numbers listing emergency response actions for particular materials.

- The green bordered pages give initial isolation and protective action distances and Toxic Inhalation hazard for the highlighted entries in the yellow and blue sections (IIPAD, TIH).

Table 1: Isolation and Protective Action distances for Toxic Inhalation Hazards

Table 2: Water-Reactive Materials Which Produce Toxic Gases

Table 3: Initial Isolation and Protective Distances for Large Spills of 6 Common TIH Gases

Containment, Confinement & Control

Introduction

Hazardous Materials spills/releases should be contained as quickly as possible to eliminate or reduce the hazard, prevent contamination of people and the environment, and to facilitate cleanup. Spills can occur in many forms and many ways. They include:

- Spills from over-turned containers.
- Spills from leaking (worn-out, punctured or breached) containers.
- Intentional spills (or dumping).
- Spills from uncontrolled - or runaway - reactions.
- Spills while taking samples.

Mitigation by means of offensive control options is reserved for the Hazardous Materials Technician. This is because special training and protective equipment is required to safely and effectively handle the incident. The Hazardous Materials Technician may be called upon to decide which chemical protective equipment will best protect the entry team during a mitigation operation. Understanding engineering controls and safe work practices during the mitigation of a spill will help the Hazardous Materials Technician in making these critical decisions. When managing a spill, there are three goals to be considered:

- Life Safety is foremost -- all actions must consider life safety.
- Protection of the Environment -- from current and new spills.
- Protection of Property -- business recovery.

No Action is a valid course of action

The First Responder at the Awareness Level (FRA) will S.I.N.

Think Safety, Isolate and Deny Entry and Notify Authorities. No further action will be taken. No approach toward the spill or attempt to contain or control the spill will be undertaken.

The First Responder at the Operations Level (FRO) will S.I.N. and C.

Think Safety, Isolate and Deny Entry and Notify Authorities and make an attempt to Contain the spill from a safe distance. The FRO can take action, however it must be from a safe distance or with the proper personal protective equipment (PPE).

With this in mind, we must also consider the nature of the spill and the nine (9) factors which affect how we deal with it.

1. Risk assessment.
2. Hazards associated with the materials.
3. State of the materials (Solid-Liquid-Gas).
4. Quantity of materials (Company and regulatory definitions).
5. Company policies (What constitutes a small or large spill?).
6. Equipment needs (Do you have what you need?).
7. Route of dispersion.
8. Secondary contamination potential (For Entry and Decontamination Team).
9. Weather.

In business or industry where the chemicals on site are known and identified, the process of containment and control can be very simple. Pre-planning is the key. Pre-planning can include:

- Knowing which containment or control method is compatible with each chemical capable of spilling.
- Having adequate supplies available to manage all emergencies.
- Establishing policies and procedures for dealing with each chemical, based on a variety of specific spill sizes.
- Training and exercising all personnel in Emergency Response

When you know what you have on site, what you are facing and how to control it before a spill occurs -- the job of mitigation and remediation is simple, fast and effective.

N.F.P.A. Spill Response Definitions

Control: "The defensive or offensive procedures, techniques and methods used in the mitigation of a hazardous materials incident, enclosing containment, extinguishment and confinement."

Confinement: "Those procedures taken to keep a material in a defined or local area once released." Confinement includes: Secondary Containment, Retaining, Isolating, Diking, Damming, Diverting & Covering.

Containment: “The actions taken to keep a material in its container (i.e., stop a release of the material or reduce the amount being released).” Containment includes: Plugging, Patching & Overpacking.

Hazardous material spills/releases should be contained as quickly as possible to eliminate or reduce the hazard, prevent contamination of people and the environment, and to facilitate cleanup. The most efficient way to control or contain a spill is to contain it early in its most concentrated form. However, containment may be made more difficult by factors such as the nature of the hazardous material, the

condition of the original containers, the extent of the spill, other hazards present in the area, geographic and weather conditions, the time of day, and lack of proper training or equipment.

SOPs must also contain contingency plans for situations when proper resources are limited or unavailable. Particularly early in a hazardous materials incident, before trained Hazardous Materials Response Teams are on scene and ready to act, personnel may be limited, proper protective clothing and containment tools may be unavailable, diking materials may be in short supply, etc. Ask yourself: "What measures can be taken to minimize the spread of contaminants before more definitive actions can be implemented?"

Response personnel must also anticipate other hazards present in the surrounding area. For example, building and fire codes prohibit ignition sources in flammable liquid storage facilities. When flammable liquids are spilled and their vapors are able to travel beyond the confines of the storage facility, ignition sources may be plentiful. What are the hazards associated with the material? What conditions are present in the surrounding area that could create a disaster? What additional precautions are necessary?

Personal Protective Equipment (PPE)

Introduction

The harmful effects of specific chemical hazards may necessitate the use of personal protective clothing and equipment when responding to a chemical emergency. Protective equipment should only be used when engineering controls are not feasible or adequate. In addition, to ensure the effectiveness of use, safe work practices must always be implemented when using personal protective equipment. Proper use and selection is a balance between the protection afforded by the items and the potential hazards caused by their use. The various stages of chemical emergency response usually necessitate the use of different types of protective items.

Determine Use

1. Prior to use;

A. Assess hazards and operational requirements.
B. Properly select equipment.
C. Plan and prioritize activities.
D. Anticipate emergencies.

2. During use;

A. Conduct periodic integrity checks.
B. Monitor for heat stress.
C. Implement safe work activities.
D. Avoid false sense of security.
E. Always use within limits.

Selection Criteria

1. Hazard assessment;

   A. Type of hazards.
   B. Degree of hazard.
   C. Duration of activity (exposure).
   D. Nature of activity.

2. Performance requirements;

   A. Resistance to chemical contaminants.
   B. Strength.
   C. Flexibility.
   D. Temperature limits.
   E. Ability to Clean.
   F. Durability.

3. Chemical resistance;

   A. Penetration: Chemical movement through the physical openings of the suit.
   B. Permeation: Chemical movement directly through the protective material.
   C. Chemical resistance charts.
   D. Degradation: Chemical attack of the protective material

4. Protective materials.

   A. Elastomers.
   B. Laminates.

Items

1. Disposable: Remove and dispose of after each use.

2. Reusable: Must be cleaned and inspected after each use.

3. Types: Suits, boots, booties, gloves, etc.

4. Standards: May be voluntary or required.

   A. ASTM / ANSI
   B. NFPA
   C. NIOSH

Equipment

1. Types.

   A. Head, eye, face, ears, respiratory, miscellaneous.

2. Standards.

A. ANSI

Levels of Personal Protective Equipment (PPE)

Level D

Not for chemical hazards. Only for minimal physical hazards.

1. Coveralls
2. Foot Protection (Boots/shoes, chemical-resistant steel toe and shank)(Outer, chemical-resistant, disposable)
3. Hand Protection (Gloves)
4. Eye Protection (Safety glasses or chemical splash goggles, face-shield)
5. Hard Hat
6. Escape Mask

Level C

For low to moderate skin hazards & for low to moderate inhalation hazards.

1. Full-face or half-mask, air purifying respirators
2. Hooded chemical-resistant clothing
3. Coveralls
4. Inner/Outer Gloves, chemical-resistant
5. Tape-up
6. Boots (outer),chemical resistant steel toe and shank
7. Boot-covers, outer, chemical-resistant (disposable)
8. Hard hat
9. Escape mask
10. Face shield

Level B

For low to moderate skin hazards & for moderate to high inhalation hazards.

1. Positive pressure, full-face, self-contained breathing apparatus (SCBA) or positive pressure supplied-air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH)
2. Hooded chemical-resistant clothing
3. Coveralls
4. Gloves, (Outer), chemical-resistant
5. Gloves, (Inner), chemical-resistant
6. Boots, outer, chemical-resistant steel toe and shank
7. Boot-covers, outer, chemical-resistant (disposable)
8. Hard hat
9. Face shield
10. Tape-up

Level A

For high skin hazards & for high inhalation hazards.

1. Positive-pressure, full face-piece, self-contained breathing apparatus (SCBA), or positive pressure supplied-air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH).
2. Totally-encapsulating chemical-protective suit.
3. Coveralls.*
4. Long underwear.*
5. Gloves, outer, chemical-resistant.
6. Gloves, inner, chemical-resistant.
7. Boots, chemical-resistant, steel toe and shank.
8. Hard hat (under suit).*
9. Disposable protective suit, gloves and boots (depending on suit construction, may be worn over totally-encapsulating suit.)

Site Control Concepts

Introduction

The purpose of site control is to establish artificial and/or physical barriers isolating various hazards from potential targets. Effective site control is based on four principal objectives:

1. Critical element in emergency scene management.
2. Access control to ensure safety.
3. Mechanism to prevent the spread of contamination.
4. Regulatory compliance.

Site control is implemented by establishing:

1. Control zones.
2. Decontamination procedures.
3. Safe work practices.

Application to Hazardous Material Responders

A variety of chemical and physical hazards may be present at any location where hazardous materials are being handled. In addition, the various environmental factors (location, terrain, weather, population proximity) may influence hazards at these job sites. Therefore, general standard operating procedures (SOPs) site control must be routinely used.

Site Control Planning

The degree of site control necessary is dependent on individual site characteristics. Site control should be established in the planning stage of a field activity so as to identify potential hazards, equipment needs, and applicable work practices. Effective site control is highly contingent on good organization (equipment, people and tasks) and planning.

Site Control Implementation

Establishing effective site control requires implementing a dynamic program adaptable to hazardous material responses. Site control procedures routinely used for all hazardous responses. When

implementing control zones it begins with the incident perimeter. Which requires isolation of the incident, beginning with the first responder and as resources and trained response increase, so does the amount of zones. Establishing effective site control requires implementing a dynamic program adaptable to individual sites

1. Site Map – Map showing equipment areas, Work zones
2. Site Preparation – Initial Isolation, Ventilation
3. Work Zones – Various
4. Buddy System – Mutual assistance
5. Site Security – Prevents unauthorized access
6. Communication – Hand signals, radios (best to have two types)
7. Safe Work Practices – Maintaining strong safety awareness
8. Exposure Minimization– Minimize number of personnel at the site

Recommended Zones

Exclusion Zone / Hot Zone: The Hot Zone incorporates all known and/or suspected contaminated areas. The Exclusion Zone defines the work area for which site hazards are identified or suspected. Entry into this zone requires the use of the highest level of protection required at the site. All personnel entering this zone must wear the prescribed level of protection specified and pass through the contamination reduction corridor upon exit.

Hotline*:* The hotline is the border between the Exclusion Zone and the Contamination Reduction Zone. Any crossing of the hotline, regardless of the nature or duration of the task (or level of protection used), requires full completion of the established decontamination procedure.

Contamination Reduction Zone / Warm Zone: Is a transition between contaminated and clean areas where decontamination is conducted. The zone provides a buffer between zones and designates adequate space (distance) to perform the established decontamination procedure. Because decontamination is considered a systematic process of reducing contamination, adequate space (physical distance) is required to isolate each step in the process. The decontamination process starts upon crossing the hotline when exiting the Exclusion Zone.

Contamination Control Line: This line is the boundary between the Contamination Reduction and Support Zone. This line delineates the outer boundary of potential contamination.

Support Zone / Cold Zone: Defines all clean, uncontaminated areas surrounding the site. Use of protective clothing or equipment is not required, and the area is used for support functions (equipment staging, rests and meals, command posts, medical support).

Decontamination

Introduction

Decontamination is the process of reducing the amount of contamination on a surface to a safe, negligible level. The process of personal decontamination involves the cleaning and/or removal of protective clothing and equipment in a specific order and by specific methods so as to prevent contamination of clean surfaces. Decontamination may not completely remove all contaminants.

Planning

Decontamination may be needed only seconds after responding to an incident. The need to exit the Exclusion Zone is unpredictable; therefore, decontamination (procedures, supplies and equipment) must be established before work begins. To satisfy this requirement, the need for decontamination (extent and level) at a specific site must be anticipated prior to beginning work.

Anticipate the need for decontamination.

A. Have necessary items available and accessible.
B. The type and extent of decontamination depends on the following:
C. Toxicity, chemical and physical properties of the contaminant.
D. Amount of contaminants.
E. Type of personal protective clothing and equipment required.
F. Work activities.
G. Anticipated use.

Contamination Process

Chemical contaminants, in the form of gases, vapors, liquids or particulates, may migrate by a variety of mechanisms. Air dispersion, run-off, surface to surface contact, and carry-out may move contaminants. Gases, vapors, liquids and particulates contacting the outer surface of chemical protective clothing may rest on, react with, or permeate into the surface of the material. Contact time, chemical concentration, temperature, contaminant molecular size, material properties and physical state of the contaminant affect protective clothing permeation.

Prevention of Contamination

A thorough and extensive decontamination procedure is not a substitute for allowing poor work practices. A false sense of security regarding the ability of the procedure to "correct" extensive contamination must be avoided. Every effort must be made by all responder to avoid contamination during all procedures.

Methods:

Standard operating procedures used to prevent contamination include:

a. Deliberate, coordinated, and planned container movement.
b. Avoid rushing or short cuts.
c. Avoid needless exposures.
d. Avoid unnecessary movement of containers.

e. Protect monitoring instruments and equipment (wrap in plastic).
f. Avoid puddles or touching contaminated surfaces.
g. Wear disposable garments.
h. Isolate sources of potential contamination (isolate leaking containers, cap containers, rope off specific areas, etc.).
i. Follow all protective equipment dress-out procedures, (NO SHORTCUTS).
j. Inspect protective equipment integrity frequently.

Decontamination Methods

General:

Decontamination methods include physical removal, inactivation (neutralization) or a combination of both.

Physical Removal: This method involves the dislodging, displacement, rinsing, wiping off or evaporation of contaminants. Physical removal can be very easy to follow and very effective. Use of disposable outer protective booties, suits and even gloves provide an automatic method for physical removal when these items are removed and disposed of as waste.

Chemical Removal: Contaminants may be detoxified or mobilized for physical removal (dissolved). Detoxification usually involves neutralization, but may incorporate other chemical processes. Mobilization usually involves changing the physical state or properties of the contaminant or its immediate environment to facilitate easier removal.

Various types of decontamination solutions may be specified and used during decontamination. Examples include

A. Solution of water and trisodium phosphate (alkaline).
B. Solution of water and hydrochloric acid (acid).
C. Solution of water and calcium hypochlorite (mild oxidizer).
D. Solution of water and detergent and/or non-solvent degreaser.

Field Decontamination

As a minimum, field decontamination must:

A. Isolate the worker
B. Provide a clearly designated zone with identified areas for each task
C. Provide containment for disposable items
D. Contain all waste streams or runoff
E. Apply field practicality

Decontamination During Emergencies

Whenever possible, decontamination procedures should be implemented in a medical emergency situation.

In a medical emergency the following guidelines should be implemented:

A. Remove protective clothing unless the removal interferes with treatment, delays treatment or aggravates the medical incident. Flush with copious amounts of water or soap and water solution.
B. Protect yourself while handling/treating the victim.
C. Alert the ambulance and medical personnel of the contaminant.

Command and Scene Management

Introduction

The ICS was developed in the 1970s because of California's severe wildland fires that were occurring. It was developed by other State and Federal fire agencies for multi-agency wildland fire suppression and operations. Incident command is a disaster or emergency management concept which calls for centralized command and coordination of all incident activities occurring within five functional areas. The five basic functions are:

1. Command
2. Operations
3. Planning
4. Logistics
5. Finance

Purpose

Purpose of Scene Management: provide one workable "System" for all responders to use, to make the most efficient and effective use of all resources, to minimize impacts of the incident.

In a Hazardous Materials Response, the Incident Command System (ICS) is the required scene management system to use.

ICS is an organized system of roles, responsibilities and SOPs used to manage and direct emergency operations.

CCR 5192(q)(3) Requires the use of "the" ICS as the command system for hazmat events. (Note: 29 CFR 1910.120 requires the use of "a site-specific Incident Command System")

CGC 8607, also known as the "Standardized Emergency Management System" (SEMS), mandates the use of ICS in any field emergency involving two or more agencies

Components of the Incident Command System

1. One Unified Command
2. Clear functional Elements
3. Flexibility and Expandability
4. Unity of Command
5. Manageable span-of-control
6. Pre-designated incident facilities
7. Effective communication and coordination

Command Organization: Major ICS Sections

1. Incident Commander
2. Safety Officer
3. Public Information Officer (PIO)
4. Liaison Officer
5. Operations Staff
6. Planning Staff
7. Logistics Staff
8. Finance Staff

Incident Commander

The Incident Commander (IC) or the Unified Command (UC) is responsible for all aspects of the response, including developing incident objectives and managing all incident operations.

Safety Officer

The Safety Officer's role is to develop and recommend measures to the IC/UC for assuring personnel health and safety and to assess and/or anticipate hazardous and unsafe situations.

Public Information Officer (PIO)

The Information Officer's role is to develop and release information about the incident to the news media, incident personnel, and other appropriate agencies and organizations.

Liaison Officer

The Liaison Officer's role is to serve as the point of contact for assisting and coordinating activities between the IC/UC and various agencies and groups.

Operations Staff

The Operations Staff is responsible for all operations directly applicable to the primary mission of the response.

Planning Staff

The Planning Staff is responsible for collecting, evaluating, and disseminating the tactical information related to the incident, and for preparing and documenting Incident Action Plans (IAPs).

Logistics Staff

The Logistics Chief manages those units which provide all support needs for an incident, including personnel, apparatus, equipment, facilities, etc.

Finance Staff

The Finance and Administrative Staff is responsible for all financial, administrative, and cost analysis aspects of the incident. These members can request services, such as accessing state or federal funds for cleanup

Incident Response Objectives

Step 1 - Set Priorities and Objectives

Step 2 - Present Considerations

Step 3 - Develop a Collective Set of Incident Objectives

Step 4 - Adopt an Overall Strategy

Step 5 - Select a UC Spokesperson

Step 6 – Manage/Mitigate the Spill Response

Incident Termination

Introduction

There are two reasons to why incident termination procedures are used.

1. It is required by law
2. It ensures proper personnel safety and that lessons learned are shared.

Procedures

Once the final clearance has been obtained from the responsible agency and the Incident Commander, it is very important that every hazardous materials incident be formally terminated by a specific, written procedure. This documentation process should include:

1. Safety procedures that were taken.
2. Description of site operations.
3. Hazards that were faced.
4. Lesson learned from operational problems.

Termination procedures also provide a record of the information and data, which may be required to be documented in order to comply with local, state, and federal laws. They will help prepare for any litigation procedures that may arise from the incident. Failure to properly terminate the incident can result in:

1. An illness to those exposed.
2. Improper clean-up techniques and unsafe disposal procedures.
3. Inaccurate assessments from the public and news media.

Termination Activities

Phase 1: Debriefing the Incident

The debriefing should occur at demobilization as soon as the emergency operation is completed. Debriefing should include the initial responders, Haz-Mat Response Team, Decontamination Team, EMS

workers, Command Staff, General Staff, Division/Group supervisors, agency representatives, and other key players as specified by the Incident Commander. An effective debriefing should:

- Inform responders what hazards they were (possibly) exposed to and explain signs and symptoms, what actions to take if they exhibit symptoms of exposure, and to ensure personnel exposures are documented.
- Identify equipment damage and unsafe conditions requiring immediate attention or isolation for further evaluation.
- Assign information-gathering responsibilities for a Post-Incident Analysis and Critique.
- Summarize the activities performed by Divisions/Groups.
- Reinforce positive aspects of the response.
- Debriefings should begin as soon as the "emergency" phase of the operation is ended.
- Ideally this should be before first responders leave the scene.
- Debriefings should be conducted in buildings or vehicles that are free from distractions.

Phase 2: Post-Incident Analysis

Post-incident analysis (PIA) activities should be assigned to a member of the Command Staff. PIA is a reconstruction of the incident to establish a clear picture of the events that took place during the incident, and should be started as soon as possible after the emergency phase of the incident. A brief chorological review of who, what, where, and when should be outlined.

Phase 3: Incident Critique

The Final Rule of 29 CFR 1910 mandates critiques for Level II and Level III hazardous materials incidents. The Incident Commander has the direct responsibility to schedule and organize the critique. Critiques should be held after the incident has been completely terminated and information has been gathered and analyzed.

- To improve efficiency
- To pinpoint weaknesses
- It is NEVER used to assign blame