



PDHonline Course C181 (8 PDH)

OSHA's Guidelines for Hazardous Waste Operations & Emergency Response (HAZWOPER) 8-HR Refresher Training

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2012

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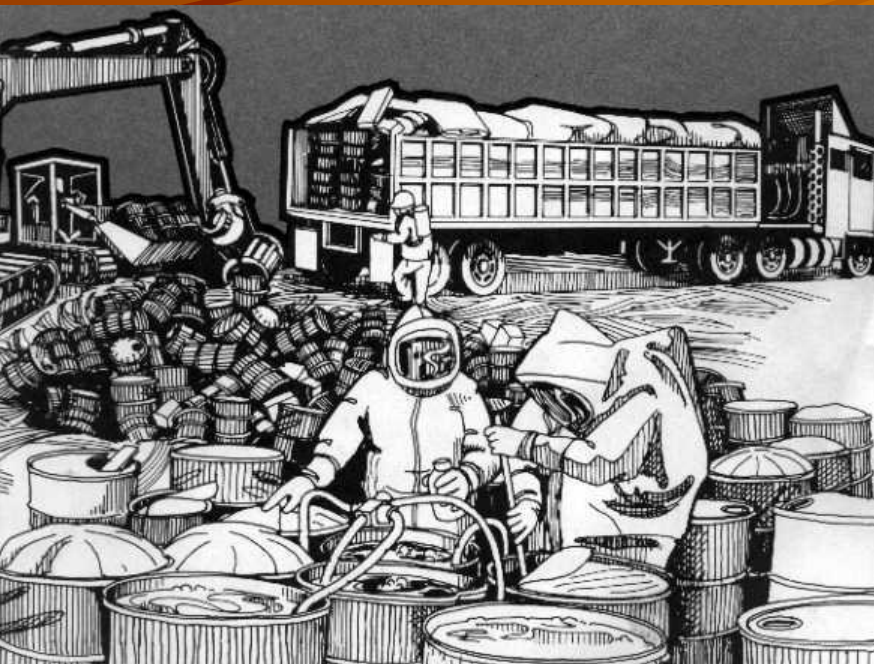
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HAZWOPER 8-HR Refresher Training

Meeting OSHA's
Guidelines for
Hazardous Waste
Operations and
Emergency Response
(HAZWOPER)
Refresher Training



Additional Help

- ◆ E-mail the instructor:
 - flnewts2002@yahoo.com
- ◆ Contact the USEPA website
 - www.epa.gov
- ◆ Contact OSHA's website
 - www.osha.gov

NIOSH/OSHA/USCG/EPA

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

Introduction

- ◆ Review the HAZWOPER Regulations
- ◆ Review Health and Safety Procedures
- ◆ Demonstrate competency in the HAZWOPER program
- ◆ Meet the requirements of the HAZWOPER 8-hr refresher course

Agenda

◆ Topics to be covered

- Lesson 1: HAZWOPER regulations
- Lesson 2: Hazards faced during operations
- Lesson 3: Planning and organization
- Lesson 4: Site Emergencies
- Lesson 5: Site characterization
- Lesson 6: Site control
- Lesson 7: Personal protective equipment
- Lesson 8: Air Monitoring



Agenda (Page 2)

- Lesson 9: Medical Program
- Lesson 10: Training Requirements
- Lesson 11: Drum Handling
- Lesson 12: Decontamination



Overview

- ◆ OSHA established HAZWOPER regulations in response to Congress passing the Superfund Amendments and Reauthorization Act (SARA) in 1986

- ◆ Begins with 40 or 24 hour training and includes annual 8 hour refresher training



Lesson 1

HAZWOPER REGULATIONS



HAZWOPER REGULATIONS

- ◆ Published at 29 CFR 1910.120
- ◆ First published in 1989
- ◆ Effective March 6, 1990
- ◆ For a copy of the current text go to www.osha.gov



Sections

- ◆ (a) Scope, application, and definitions
- ◆ (b) Safety and health program
- ◆ (c) Site characterization and analysis
- ◆ (d) Site control
- ◆ (e) Training
- ◆ (f) Medical surveillance

Sections (Page 2)

- ◆ (g) Engineering controls and work practices
- ◆ (h) Monitoring
- ◆ (i) Informational programs
- ◆ (j) Handling drums and containers
- ◆ (k) Decontamination
- ◆ (l) Emergency response by employees at uncontrolled hazardous waste sites

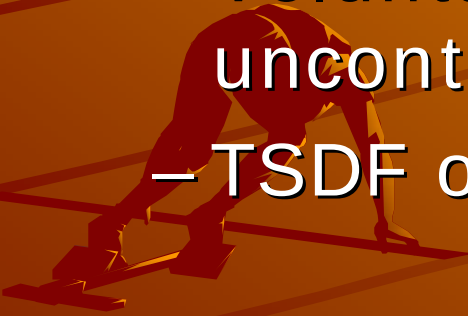
Sections (Page 3)

- ◆ (m) Illumination
- ◆ (n) Sanitation at temporary workplace
- ◆ (o) New technology programs
- ◆ (p) Certain operations conducted under RCRA
- ◆ (q) Emergency response program to hazardous substance releases

29 CFR 1910.120(a): Scope

◆ Covered Operations

- Governmental clean-up operations
- RCRA corrective actions
- Voluntary clean-up operations at uncontrolled hazardous waste sites
- TSDF operations



Key Definitions



Buddy system

A system of organizing employees into work groups in such a manner that each employee of the work group is designated to be observed by at least one other employee in the work group in order to provide rapid assistance to employees in the event of an emergency. 29 CFR 1910.120(a)(3)

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Clean-up operations

An operation where hazardous substances are removed, contained, incinerated, neutralized, stabilized, cleaned-up or in any other manner processed or handled with the ultimate goal of making the site safer for people or the environment. 29

CFR 1910.120(a)(3)

Decontamination

The removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of foreseeable adverse health effects.

29 CFR 1910.120(a)(3)



Emergency response

A response effort by employees from outside the immediate release area or by other designated responders to an occurrence which results, or is likely to result in an uncontrolled release of a hazardous substance. 29

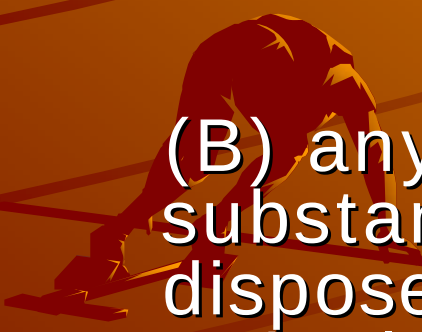
CFR 1910.120(a)(3)

Instances not defined as emergency response:

- ◆ Incidental releases of hazardous substances where the substance can be absorbed, neutralized or otherwise controlled at the time of release by employees in the immediate release area or by maintenance personnel.
- ◆ Releases of hazardous substances where there is no potential safety or health hazard. 29 CFR 1910.120(a)(3)

Facility

(A) any building, structure, installation, equipment, pipe or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, storage container, motor vehicle, rolling stock, or aircraft, or

A silhouette of a person in a starting crouch on a track, positioned to the left of the text for item (B).

(B) any site or area where a hazardous substance has been deposited, stored, disposed of or placed or otherwise come to be located; but does not include any consumer product in consumer use or any water-borne vessel 29 CFR 1910.120(a)(3)

First responder

Individuals who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the proper authorities of the release, 29 CFR 1910.120(q)(6)(i)

A silhouette of a person in a starting crouch, positioned on the left side of the slide, partially overlapping the text.

Hazardous materials response (HAZMAT) team

An organized group of employees, designated by the employer, who are expected to perform work to handle and control actual or potential leaks or spills of hazardous substances requiring possible close approach to the substance. The team members perform responses to releases or potential releases of hazardous substances for the purpose of control or stabilization of the incident. A HAZMAT team is not a fire brigade nor is a typical fire brigade a HAZMAT team. A HAZMAT team, however, may be a separate component of a fire brigade or a fire department, 29 CFR 1910.120(a)(3)

Hazardous substance

- ❖ Any substance designated or listed on the next 4 slides, exposure to which results or may result in adverse effects on the health of the employees, 29 CFR 1910.120(a)(3)



A

❖ Any substance defined under Section 101(14) of CERCLA.



B

- ◆ Any biologic agent and other disease causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions or physical deformations in such persons or their offspring.

C

- ❖ Any substance listed by the U.S. Department of Transportation (DOT) as hazardous materials under 49 CFR 172.101 and appendices.



D

- ❖ Hazardous wastes including
 - Those wastes or combination of wastes defined in 40 CFR 261.3 or
 - Those substances defined as hazardous wastes in 49 CFR 171.8.



Hazardous waste

(A) A waste or combination of wastes as defined in 40 CFR 261.3, or

(B) Those substances defined as hazardous wastes in 49 CFR 171.8, 29 CFR 1910.120(a)(3)

Hazardous waste operations

Any operation conducted within the scope of this standard



Hazardous waste site

Any facility or location within the scope of this standard at which hazardous waste operations take place, 29 CFR 1910.120(a)(3)



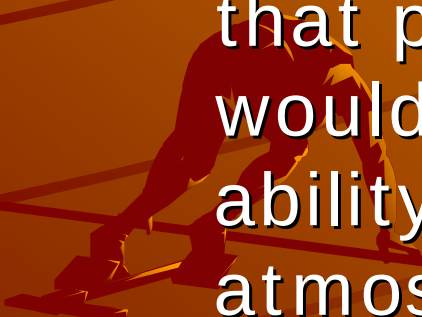
Health hazard

A chemical, mixture of chemicals or a pathogen for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees.

Includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. It also includes stress due to temperature extremes, 29 CFR 1910.120(a)(3)

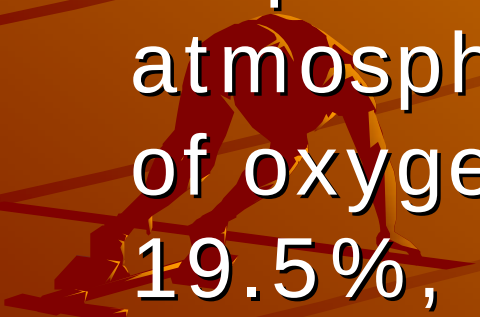
Immediately dangerous to life or health (IDLH)

An atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would interfere with an individual's ability to escape from a dangerous atmosphere, 29 CFR 1910.120(a)(3)

A silhouette of a person in a starting crouch on a track, positioned to the left of the text.

Oxygen deficiency

That concentration of oxygen by volume below which atmosphere supplying respiratory protection must be provided. It exists in atmospheres where the percentage of oxygen by volume is less than 19.5%, 29 CFR 1910.120(a)(3)



Permissible exposure limit (PEL)

The exposure, inhalation or dermal permissible exposure limit specified in 29 CFR Part 1910, Subparts G and Z, 29 CFR 1910.120(a)(3)

Published exposure level

The exposure limits published in “NIOSH Recommendations for Occupational Health Standards” dated 1986, which is incorporated by reference as specified in Sec. 1910.6, or if none is specified, the exposure limits published in the standards specified by the American Conference of Governmental Industrial Hygienists in the publication “Threshold Limit Values and Biological Exposure Indices for 1987-88” dated 1987, which is incorporated by reference as specified in Sec. 1910.6, 29 CFR 1910.120(a)(3)

Post emergency response

That portion of an emergency response performed after the immediate threat of a release has been stabilized or eliminated and clean-up of the site has begun. If post emergency response is performed by an employer's own employees who were part of the initial emergency response, it is considered to be part of the initial response and not post emergency response. However, if a group of an employer's own employees, separate from the group providing initial response, performs the clean-up operation, then the separate group of employees would be considered to be performing post emergency response and subject to paragraph (q)(11) of this section, 29 CFR 1910.120(a)(3)

Qualified person

- ❖ Any person with specific training, knowledge and experience in the area for which the person has the responsibility and the authority to control, 29 CFR 1910.120(a)(3)



Senior official

The most senior official on the site of an emergency response who has the responsibility for controlling the operations at the site, 29 CFR 1910.120(q)(3)(i)



Site safety and health supervisor

- ◆ The individual located on a hazardous waste site who is responsible to the employer and has the authority and knowledge necessary to implement the site safety and health plan and verify compliance with applicable safety and health requirements (also may be referred to as the Site Safety and Health Officer, SSHO), 29 CFR 1910.120(a)(3)

Small quantity generator

A generator of hazardous wastes who in any calendar month generates no more than 1,000 kilograms (2,205 pounds) of hazardous waste in that month, 29 CFR 1910.120(a)(3)



Uncontrolled hazardous waste site

- ❖ An area identified as an uncontrolled waste site by a governmental body where an accumulation of hazardous substances creates a threat to the health and safety of individuals or the environment or both. Normal operations at TSD sites are not covered by this definition, 29 CFR 1910.120(a)(3)

29 CFR 1910.120(b)

Safety and Health Program (SHP)



Safety and health programs developed and implemented to meet other federal, state, or local regulations are considered acceptable and an additional program is not required under this program.

Purpose of SHP

- ◆ Identify safety and health hazards
- ◆ Evaluate safety and health hazards
- ◆ Control safety and health hazards
- ◆ Provide for emergency response for hazardous waste operations



SHP Elements

- ◆ Organizational structure
- ◆ Comprehensive workplan
- ◆ A site-specific health and safety plan
- ◆ A safety and health training program
- ◆ A medical surveillance program
- ◆ Standard operating procedures for health and safety

SHP Elements (Page 2)

- ◆ Provide the necessary interface between general program and site specific activities
- ◆ Site excavations must comply with 29 CFR Part 1926
- ◆ Inform contractors and subcontractors of program elements
- ◆ Make written program available to any contractor, subcontractor, employees, OSHA personnel and other federal state and local agencies

SHP organization elements

- ◆ Outline a specific chain of command and specify responsibilities of supervisors and employees
- ◆ Name a general supervisor who directs all hazardous waste operations
- ◆ Name a site safety and health supervisor
- ◆ Lines of authority, responsibility and communication
- ◆ Review and update structure as necessary



SHP Workplan

Should address tasks and objectives of site operations and the logistics and resources required to reach these tasks and objectives. It should:

- ◆ Define work tasks and objectives

- ◆ Establish personnel requirements

- ◆ Detail training requirements

- ◆ Address drum and container handling



Site health and safety plan

- ◆ A site safety and health risk or hazard analysis for each task and operation
- ◆ Employee training assignments
- ◆ Personal protective equipment to be used by employees for each site task
- ◆ Medical surveillance requirements
- ◆ Frequency and types of air monitoring, personnel monitoring and environmental sampling techniques and instrumentation



Site health and safety plan (Page 2)

- ◆ Site control measures to be used
- ◆ Decontamination procedures
- ◆ Confined space entry procedures
- ◆ Emergency response program
- ◆ Spill containment program
- ◆ Must be kept on site
- ◆ Pre-entry briefings must be conducted for all personnel
- ◆ Effectiveness of plan shall be periodically evaluated

29 CFR 1910.120(c) Site characterization

Hazardous waste sites shall be evaluated to identify specific site hazards and to determine the appropriate safety and health control procedures needed to protect employees from the identified hazards



Site characterization

- ◆ Preliminary evaluation prior to site entry by a qualified person
- ◆ More detailed evaluation after initial site entry
- ◆ Hazard identification of suspected conditions that may pose inhalation or skin absorption hazards that are immediately dangerous to life or health (IDLH) or other conditions that may cause death or serious injury



Site characterization required information

- ◆ Location and approximate size of site
- ◆ Description of response activity
- ◆ Duration of planned employee activities
- ◆ Site topography and accessibility by air/roads
- ◆ Safety and health hazards expected
- ◆ Pathways for hazardous substance dispersion



Site characterization required information (Page 2)

- ◆ Present status and capabilities of emergency response teams
- ◆ Hazardous substances and health hazards and their chemical and physical properties
- ◆ PPE required by site personnel
- ◆ Monitoring during initial site entry under IDLH conditions and ongoing air monitoring after the site is safe for startup
- ◆ Risk identification
- ◆ Employee notification of chemical, physical and toxicologic properties of each substance



Risks to Consider

- ◆ Exposures exceeding the permissible exposure limits (PEL) and published exposure levels
- ◆ IDLH concentrations
- ◆ Potential skin absorption and irritation sources
- ◆ Potential eye irritation sources
- ◆ Explosion sensitivity and flammability ranges
- ◆ Oxygen deficiency



29 CFR 1910.120(d)

Site control

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Appropriate site control procedures shall be implemented to control employee exposure to hazardous substances before clean-up work can begin

Site control elements

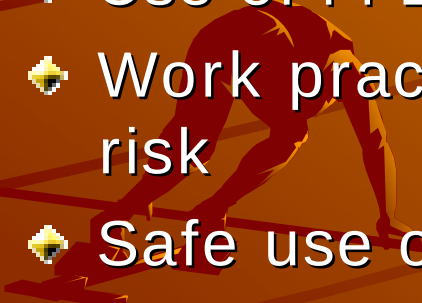
- ◆ A site map
- ◆ Site work zones
- ◆ Use of the “buddy system”
- ◆ Site communications
- ◆ Standard operating procedures or safe work practices
- ◆ Identification of nearest medical assistance

29 CFR 1910.120(e)

Training

All employees working on site exposed to hazardous substances, health hazards or safety hazards and their supervisors and management responsible for the site shall receive appropriate training before they are permitted to engage in hazardous waste operations that could expose them to the covered hazards.

Training elements

- ◆ Names of personnel and alternates responsible for site safety and health
 - ◆ Safety, health, and other hazards present on site
 - ◆ Use of PPE
 - ◆ Work practices by which employees can minimize risk
 - ◆ Safe use of engineering controls and equipment
 - ◆ Medical surveillance requirements, including recognition of symptoms that indicate overexposure
- 
- A silhouette of a person in a starting crouch, positioned on the left side of the slide, partially overlapping the list items. The person is in a low, forward-leaning position with hands on the ground, typical of a starting stance in track and field.

Initial training

- ◆ General site workers engaged in hazardous substance removal shall receive a minimum of 40 hours of instruction and 3 days of actual field experience
- ◆ Workers on site only occasionally for a specific limited task shall receive 24 hours of instruction and 1 day of actual field experience



Initial training (Page 2)

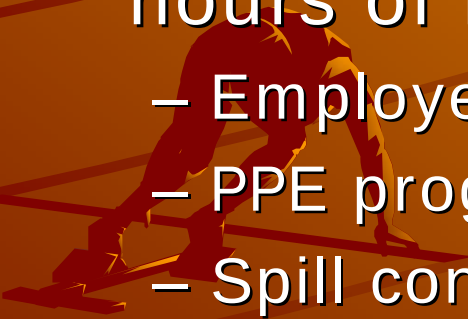
❖ Workers regularly on site who work in areas which have been monitored and fully characterized, indicating exposure below permissible limits shall receive 24 hours of instruction and 1 day of actual field experience

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❖ Workers with 24 hours of training who become general site workers must have an additional 16 hours of instruction and 2 days of training

Supervisor training

- ◆ On site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations shall receive an additional 8 hours of instruction that should include
 - Employer's safety and health program
 - PPE program
 - Spill containment program
 - Health hazard monitoring procedures and techniques



Trainer qualifications

- ◆ Trainers shall be qualified to instruct employees. They must
 - Have completed a training program for teaching the subjects or
 - Have the academic credentials and instructional experience necessary to teach the subjects
 - Demonstrate competent instructional skills and knowledge



Training certification

- ◆ Employees and supervisors that have successfully completed the training shall be certified by the instructor
- ◆ Certification shall be in writing and given to the student upon completion



Other training requirements

- ◆ Employees engaged in responding to hazardous emergency situations shall be trained in how to respond to such expected emergencies
- ◆ 8 hours of refresher training shall be conducted annually for all covered personnel
- ◆ Equivalent training, if documented, is acceptable; however, site specific training is still required

29 CFR 1910.120(f)

Medical surveillance



Employers shall institute a medical surveillance program for all employees engaged in operations covered under the regulations

Employees covered

- ◆ All employees who are or may be exposed to hazardous substances or health hazards or above established PELs
- ◆ All employees who wear a respirator for 30 or more days per year
- ◆ All employees who are injured, become ill or develop signs or symptoms due to possible overexposure
- ◆ Members of HAZMAT teams

Frequency of examinations

- ◆ Prior to assignment
- ◆ At least once every 12 months while working at a site
- ◆ At termination or reassignment
- ◆ Immediately after an exposure incident or injury, illness, etc.
- ◆ As required by physician



Content of medical examination

- ◆ Medical and work history with special emphasis on symptoms related to the handling of hazardous substances and health hazards and to fitness for duty including the ability to wear required PPE
- ◆ Content determined by attending physician
- ◆ All medical examinations and procedures shall be provided without cost to employee, without loss of pay and at a reasonable time and place

Material provided to physician

- ◆ Copy of standard
- ◆ Description of employee's duties
- ◆ Employee's exposure or anticipated exposure levels
- ◆ Description of PPE used or to be used
- ◆ Information from prior examinations
- ◆ Information required under respiratory protection program (29 CFR 19120.134)

Physician's opinion

- ◆ In writing
- ◆ Whether employee can use PPE
- ◆ Any recommended work limitations
- ◆ Results of medical examination and tests
- ◆ Statement that employee has been informed of the results and any medical conditions
- ◆ Not reveal specific findings or diagnosis unrelated to occupational exposure

Recordkeeping

- ◆ Names and social security no. of employee
- ◆ Physician's written opinion, recommended limitations and results of examinations
- ◆ Any employee medical complaints related to exposure to hazardous substances
- ◆ A copy of information provided to the physician by the employer
- ◆ Kept in accordance with 29 CFR 1910.20

29 CFR 1910.120(g)

Engineering controls and practices

- ◆ Instituted to reduce and maintain employee exposure at or below permissible levels
- ◆ When not feasible, or not required, any combination of engineering controls, work practices and PPE shall be used
- ◆ Worker rotation may not be used when complying with the airborne or dermal dose limits for ionizing radiation

PPE selection

- Selected to protect employees from the hazards and potential hazards they are likely to encounter
- An evaluation of PPE performance characteristics based on:
 - Requirements and limitations of the site
 - Task-specific conditions and duration
 - Hazards and potential hazards of site



PPE Selection (Page 2)

- ◆ Positive pressure SCBAs or positive pressure air lines shall be used when chemical exposure present will create a substantial possibility of immediate death, serious illness or injury or impair the ability to escape

- ◆ Totally encapsulating chemical protective suits shall be used where skin absorption of a hazardous substance may result in a substantial possibility of immediate death, serious illness or injury or impair the ability to escape



PPE Selection (Page 3)

- ◆ PPE selection shall be increased when additional information or site conditions show that increased exposure is necessary



- ◆ PPE shall be selected and used in accordance with 29 CFR Part 1910, Subpart I

Totally encapsulated chemical suits

- ◆ Shall protect employees from the particular hazards which have been identified
- ◆ Shall be capable of maintaining positive air pressure
- ◆ Shall be capable of preventing inward test gas leakage of more than 0.5 percent



PPE program includes

- ❖ PPE selection based upon site hazards
- ❖ PPE use and the limitations of equipment
- ❖ Work mission duration
- ❖ PPE maintenance and storage
- ❖ PPE decontamination and disposal
- ❖ PPE training and proper fitting
- ❖ PPE donning and doffing
- ❖ PPE inspection procedures
- ❖ Evaluation of the effectiveness of the PPE program
- ❖ Limitations due to temperature extremes, heat stress and other medical considerations

29 CFR 1910.120(h)

Monitoring

- ❖ Air monitoring shall be used to identify and quantify airborne levels of hazardous substances and safety and health hazards
- ❖ Representative air monitoring shall be conducted on initial entry
- ❖ Periodic monitoring shall be conducted

Initial entry monitoring

- ◆ Identify any IDLH conditions
- ◆ Identify exposure over permissible limits
- ◆ Identify exposure over published exposure levels
- ◆ Identify exposure over a radioactive material's dose limits
- ◆ Identify other dangerous conditions, such as the presence of flammable atmospheres or oxygen-deficient environments

Periodic monitoring

- ◆ Instituted when the possibility of an IDLH condition or flammable atmosphere has developed
- ◆ Instituted when there is an indication that exposures may have risen over permissible limits or published exposure levels since prior monitoring

Situations requiring periodic monitoring

- ◆ When work begins on a different portion of the site
- ◆ When a different type of operation is initiated
- ◆ When employees are handling leaking drums or containers
- ◆ When employees are working in areas with obvious liquid contamination

29 CFR 1910.120(i)

Informational Programs

Employers shall develop and implement a program to inform employees, contractors and subcontractors of the nature, level and degree of exposure likely as a result of participation in hazardous waste operations

29 CFR 1910.120(j)

Handling drums and containers

- ◆ Drums shall meet all DOT, OSHA, and EPA regulations
- ◆ Drums and containers shall be inspected and their integrity assured prior to being moved
- ◆ Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly
- ◆ Site operations shall minimize the amount of drum or container movement

Drums and containers (Page 2)

- ◆ Employees shall be warned of the hazards of the contents of the drums prior to movement
- ◆ US DOT salvage drums and suitable quantities of absorbents shall be kept available
- ◆ A spill containment program shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred

Drums and containers (Page 3)

- ◆ Drums and containers that may rupture, leak or spill shall be emptied into a sound container before movement
- ◆ A ground-penetrating system shall be used to estimate the location and depth of buried drums or containers
- ◆ Soil or covering material shall be removed with caution
- ◆ Fire extinguishing material shall be on hand and ready for use

Opening drums and containers

- ◆ Where airline respirators are used, connections to the source of air supply shall be protected
- ◆ Employees not involved in opening drums shall be kept a safe distance from the drums being opened
- ◆ A suitable shield shall be used between the employee working near the operation and the drums being opened

Opening drums and containers

(Page 2)

- ◆ Controls for drum or container opening equipment, monitoring equipment and fire suppression shall be located behind an explosion-resistant barrier
- ◆ Material handling equipment and hand tools shall be explosion-proof where required
- ◆ Employees shall not stand upon or work from drums or containers

Opening drums and containers (Page 3)

- ◆ Material handling equipment shall be selected, positioned and operated to minimize sources of ignition
- ◆ Drums and containers containing radioactive wastes shall not be opened until their hazards to employees are properly assessed



Opening drums and containers – shock sensitive wastes

- ❖ All non-essential employees shall be evacuated
- ❖ Material handling equipment shall have explosive containment devices or protective equipment
- ❖ An employee alarm system shall be used to signal the commencement and completion of activities

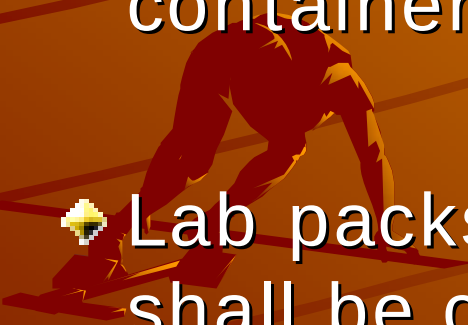
Opening drums and containers

– shock sensitive wastes

- ◆ Continuous communication shall be maintained between the employee in charge of the area and site safety and health officer and the command post
- ◆ Drums that are bulging under pressure shall not be moved until appropriate containment procedures have been implemented
- ◆ Drums containing lab wastes shall be considered containing shock sensitive or explosive materials

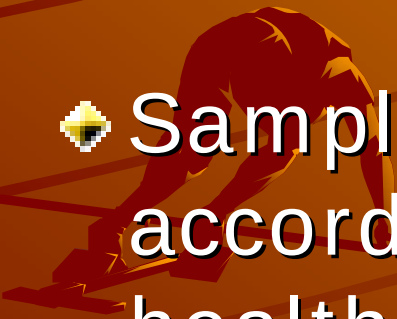
Lab waste packs

- ◆ Lab packs shall be opened only when necessary and then only by an individual knowledgeable in the inspection, classification and segregation of the containers within the pack
- ◆ Lab packs containing crystalline materials shall be considered shock sensitive until the contents are identified



Sampling of drums and containers

- ◆ Sampling shall be performed in accordance with the site safety and health plan



Drum shipping and transport

- ◆ Drums and container shall be identified and classified prior to packaging
- ◆ Drum or container staging areas shall be kept to the minimum number necessary to safely identify and classify materials and prepare them for transport
- ◆ Staging areas shall be provided with adequate access and egress routes
- ◆ Bulking of hazardous wastes shall be permitted only after a thorough characterization of the materials

Tanks and vault procedures

- ◆ Tanks and vaults shall be handled in a manner similar to drums and containers taking into consideration the size of the tank or vault
- ◆ Appropriate tank or vault entry procedures shall be followed

29 CFR 1910.120(k)

Decontamination

- ◆ Decontamination procedures shall be developed and communicated to employees before site entry
- ◆ Standard operating procedures shall be developed to minimize employee contact with hazardous substances
- ◆ All employees leaving a contaminated area shall be deconned; all clothing and equipment shall be disposed of or decontaminated

Decontamination (Page 2)

- ◆ Decontamination procedures shall be monitored by the site safety and health supervisor to determine their effectiveness
- ◆ Decontamination shall be performed in areas that will minimize the exposure of uncontaminated employees or equipment
- ◆ All equipment and solvents used for decontamination shall be decontaminated or properly disposed

PPE Decontamination

- ◆ Protective clothing and equipment shall be decontaminated, cleaned, laundered, maintained or replaced as needed
- ◆ Employees whose non-impermeable clothing becomes wetted with hazardous substances shall immediately remove that clothing and proceed to shower
- ◆ Unauthorized employees shall not remove protective clothing or equipment from change rooms

PPE Decontamination (Page 2)

- ❖ Commercial laundries or cleaning establishments shall be informed of the potentially harmful effects of exposure to hazardous substances

- ❖ Regular showers and change rooms shall meet the requirements of 29 CFR 1910.141

29 CFR 1910.120(I)

Emergency response plan

- ◆ An emergency response plan shall be in writing and available for inspection and copying by employees, their representatives, OSHA personnel and other governmental agents

- ◆ Employers who will evacuate all personnel from the danger area when an emergency occurs and who do not permit any employees to assist in handling the emergency are exempt from this requirement

Emergency response plan elements

- ◆ Pre-emergency planning and coordination with outside parties
- ◆ 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

Emergency response plan elements (Page 2)

- ◆ Decontamination procedures not covered by the site health and safety plan
- ◆ Emergency medical treatment and first aid
- ◆ Emergency alerting and response procedures
- ◆ Critique of response and follow-up
- ◆ PPE and emergency equipment
- ◆ Procedures for handling emergency incidents

Emergency response plan elements (Page 3)

- ◆ Site topography, layout and prevailing weather conditions
- ◆ Procedures for reporting incidents to local, state and federal agencies
- ◆ Be compatible with and integrated with disaster, fire and/or emergency response plans of local, state and federal agencies
- ◆ A separate section of the site health and safety plan

Emergency response plan elements (Page 4)

- ◆ Be rehearsed regularly as part of plant training
- ◆ Be reviewed periodically and, as necessary, amended to keep it current
- ◆ An employee alarm system shall be installed in accordance with 29 CFR 1910.165
- ◆ Implement plan based upon a review of any incidents and site response capabilities

29 CFR 1910.120(m) Illumination

Meet the following minimum levels



Minimum illumination

Foot-Candles	Area of Operations
5	General site areas
3	Excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas
5	Indoors: warehouses, corridors, hallways and exit ways
5	Tunnels, shafts and general underground work areas
10	General shops
30	First aid stations, infirmaries and offices

29 CFR 1910.120(n)

Sanitation at temporary workplaces

- ◆ Potable water shall be provided at the site
- ◆ Potable water containers shall be capable of being tightly closed and equipped with a tap
- ◆ Potable water containers shall be clearly marked
- ◆ Non-potable water outlets must be clearly marked as unsuitable for drinking

Toilet facilities

No. of employees	Minimum number of facilities
20 or fewer	1
More than 20, fewer than 200	1 toilet seat and 1 urinal per 40 employees
More than 200	1 toilet seat and 1 urinal per 50 employees

Toilet facilities (Page 2)

- ◆ Under temporary field conditions, provisions shall be made to assure that not less than 1 is available
- ◆ Hazardous waste sites shall be provided with the following
 - Sanitary sewers
 - Chemical toilets
 - Recirculating toilets
 - Combustion toilets
 - Flush toilets

Additional sanitary requirements

- ◆ Mobile crews having transportation readily available to nearby toilets are exempt
- ◆ All food service facilities and operations shall meet applicable laws, ordinances, etc.
- ◆ Temporary sleeping quarters shall be heated, ventilated and lighted
- ◆ Adequate washing facilities shall be provided near the worksite

Additional sanitary requirements

(Page 2)

- ◆ When hazardous waste clean-up will last more than 6 months, showers and change rooms shall be provided that meet 29 CFR 1910.141(d)(3) for showers and 29 CFR 1910.141(e) for change rooms
- ◆ Showers and change rooms shall be located where exposure levels are below permissible exposure limits or have adequate ventilation

29 CFR 1910.120(o)

New technology program

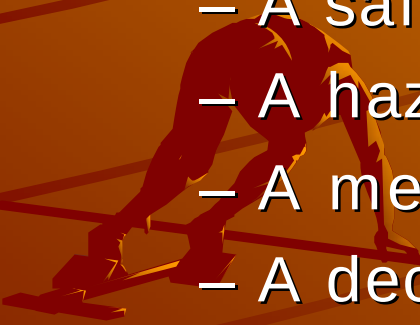
- ◆ The employer shall develop and implement procedures for the introduction of effective new technologies and equipment
- ◆ New technologies shall be evaluated by employers or their representatives and shall be made available to OSHA upon request

29 CFR 1910.120(p)

Operations at RCRA TSDFs

◆ Employer shall develop and implement the following (elements covered in prior sections):

- A safety and health program
- A hazard communication program
- A medical surveillance program
- A decontamination program
- A new technology program
- A material handling program
- A training program
- An emergency response program



TSDF training program

- ❖ New employees shall have 24 hours of initial instruction and 8 hours annual refresher
- ❖ Current employees shall demonstrate knowledge and experience to meet initial training, but must have 8 hours of annual refresher
- ❖ Employee members of TSDF emergency response organizations must be trained to a level of competence in the recognition of health and safety hazards to protect themselves and other employees

Exceptions to full response training

- ◆ Not all employees need to be trained if some have been trained in emergency response and others who may first respond have awareness training to recognize that a situation exists and to summon more highly trained persons
- ◆ Not all need training if an outside fully-trained response team can respond in a reasonable time and all employees have awareness training

29 CFR 1910.120(q) Emergency response program to hazardous substance releases

A silhouette of a person in a starting crouch on a track, positioned to the left of the text.

Emergency response plan shall be
developed and implemented that
includes all prior elements

Procedures for handling emergency response

- ◆ The senior emergency response official responding to an emergency shall become the individual in charge (IC) of a site-specific incident command system (ICS)
- ◆ The IC shall identify all hazardous substances or conditions present and shall address:
 - Site analysis
 - Use of engineering controls
 - Maximum exposure limits
 - Hazardous substance handling procedures
 - Use of any new technologies

Procedures for handling emergency response (Page 2)

- ◆ The IC shall implement appropriate emergency operations and assure PPE is used
- ◆ Employees shall use positive pressure SCBAs until IC determines they are not needed
- ◆ The IC shall limit the number of emergency response personnel at the emergency site

Procedures for handling emergency response (Page 3)

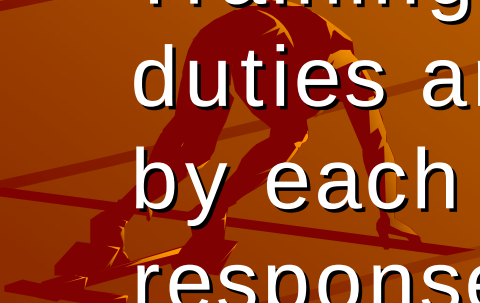
- ◆ Back up personnel shall be standing by with equipment ready to provide assistance
- ◆ The IC shall designate a safety officer
- ◆ When the safety officer judges an IDLH and/or an imminent danger condition exists, the work activities shall be altered, suspended or terminated
- ◆ The IC shall implement appropriate decontamination measures after emergency operations have terminated

Procedures for handling emergency response (Page 4)

- ◆ Skilled employees, though not HAZWOPER trained and not part of the normal response team, shall receive an initial briefing at the site prior to participation
- ◆ Specialist employees who may provide technical advice shall receive training or demonstrate competency in the area of their specialization annually

Training

Training shall be based upon the duties and functions to be performed by each responder of an emergency response organization

A silhouette of a person in a starting crouch, positioned on the left side of the slide, partially overlapping the text. The person is in a low, forward-leaning position with hands on the ground, typical of a starting stance in track and field.

First responder awareness level training

- ◆ Understanding of what hazardous substances are and the associated risks
- ◆ Understanding of potential outcomes associated with an emergency created when hazardous substances are present
- ◆ Ability to recognize the presence of hazardous substances
- ◆ Ability to identify the hazardous substances

First responder awareness level training (Page 2)

- ◆ Understanding of the role of the first responder awareness individual in the employer's emergency response plan
- ◆ Ability to recognize the need for additional resources and to make appropriate notifications to the communication center

First responder operations level training

- ◆ Knowledge of the basic hazard and risk assessment techniques
- ◆ Know how to select and use proper PPE
- ◆ Understanding of basic hazardous materials terms
- ◆ Know how to perform basic control, containment and/or confinement operations within the capabilities of the resources and PPE available to them

First responder operations level training (Page 2)

- ◆ How to implement basic decontamination procedures
- ◆ Understanding of relevant SOPs and termination procedures



Hazardous materials technician training

- ◆ How to implement the employer's emergency response plan
- ◆ Know the classification, identification and verification of known and unknown materials by field survey instruments and equipment
- ◆ Be able to function within an assigned role in the ICS

Hazardous materials technician training (Page 2)

- ◆ Know how to select and use proper PPE
- ◆ Understand hazard and risk assessment techniques
- ◆ Be able to perform advanced control, containment and/or confinement operations
- ◆ Understand termination procedures
- ◆ Understand basic chemical and toxicological terminology and behavior

Hazardous materials specialist training

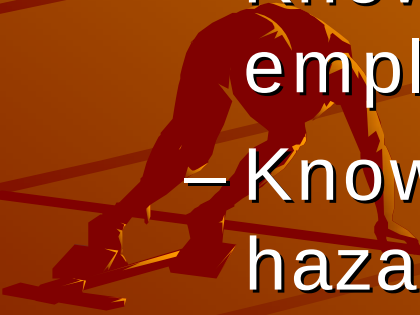
- ◆ How to implement the local emergency response plan
- ◆ Understand classification, identification and verification of known and unknown materials by using advanced survey instrumentation and equipment
- ◆ Know the state emergency response plan
- ◆ Be able to select and use proper PPE

Hazardous materials specialist training (Page 2)

- ◆ Understand in-depth hazard and risk techniques
- ◆ Be able to perform specialized control, containment and/or confinement operations
- ◆ Be able to determine and implement decontamination procedures
- ◆ Have the ability to develop a site safety and health plan
- ◆ Understand chemical, radiological and toxicological terminology and behavior

On scene incident commander training

- ◆ Have 24 hour training the same as the first responder operations level and demonstrate:
 - Knowledge of and be able to implement employer's ICS
 - Knowledge of and understand the hazards and risks associated with employees working in chemical PPE
 - Knowledge of how to implement the local emergency response plan



On scene incident commander training (Page 2)

- ◆ Knowledge of the state emergency response plan and of the Federal Regional response Team
- ◆ Knowledge of and understand the importance of decontamination



Trainers

- ◆ Have completed a training course for teaching the subjects or
- ◆ Training and/or academic credentials and instructional experience to demonstrate competent instructional skills
- ◆ Good command of the subject matters they are teaching



Refresher training

- ❖ Annual refresher training is required for all covered personnel
- ❖ Training shall be sufficient to demonstrate competency



Medical surveillance and consultation

- ❖ Members of an organized and designated HAZMAT team and hazardous materials specialist shall have a baseline physical examination and be provided with medical surveillance as previously discussed
- ❖ Employees exhibiting signs or symptoms which may have resulted from exposure to hazardous substances shall be provided medical consultation

Post emergency response operations

- ◆ Post emergency response clean-up personnel shall:
 - Meet the requirements of this section or
 - For clean-up on plant property using plant or workplace employees, employees shall meet the training requirements of 29 CFR 1910.38(a), 1910.134, 1910.1200 and other appropriate safety and health training made necessary by their tasks



LESSON 2



Hazards faced during
operations

Hazards faced during operations

- ◆ Hazards result from the nature of the site
- ◆ Hazards result from the uncontrolled nature of site conditions
- ◆ Hazards are a function of the nature of work being performed
- ◆ Hazards result from the large variety and number of substances that may be present at the site
- ◆ Accurate assessment of site is often impossible
- ◆ Identity of substances is frequently unknown

Hazards faced during operations (Page 2)

- ◆ Protective measures often based on little or no information
- ◆ Hazards posed by the disorderly physical environment of hazardous waste sites
- ◆ Hazards due to the stress of working in protective clothing

Hazards faced during operations

(Page 3)

- ◆ Hazards may pose an immediate danger to life or health (IDLH)
- ◆ Hazards may not be immediately obvious or identifiable
- ◆ Hazards may vary according to the location on site and the task being performed
- ◆ Hazards may change as site activities progress

TYPES OF HAZARDS

- ◆ Chemical exposure
- ◆ Fire and explosion
- ◆ Oxygen deficiency
- ◆ Ionizing radiation
- ◆ Biologic hazards
- ◆ Safety/physical hazards
- ◆ Electrical hazards
- ◆ Heat stress
- ◆ Cold exposure
- ◆ Noise

Chemical exposure

- ◆ Sites contain a variety of chemical substances in gaseous, liquid and solid forms
- ◆ Can enter unprotected body via inhalation, skin absorption, ingestion or skin punctures wounds (injection)
- ◆ Can cause injury at point of contact, systemically throughout the body, or have a toxic effect at a body part distant from the initial point of contact

Chemical exposure (Page 2)

- ◆ Acute effects symptoms occur during or shortly after exposure to high concentrations of a chemical(s)
- ◆ Acute effects vary widely based on chemical
- ◆ Chronic effects symptoms occur due to low concentrations of a chemical(s) over a long period of time
- ◆ Chronic effects depend upon chemical, duration of exposure, and the number of exposures

Chemical exposure (Page 3)

- ❖ Acute and chronic symptoms may be completely different
- ❖ Acute and chronic symptoms may be temporary and reversible or may be permanent or cause death



Signs of overexposure to chemicals

- ◆ Burning
- ◆ Coughing
- ◆ Nausea
- ◆ Tearing eyes
- ◆ Rashes
- ◆ Cancer
- ◆ Respiratory disease
- ◆ Dulled sense of smell
- ◆ May not produce any obvious signs

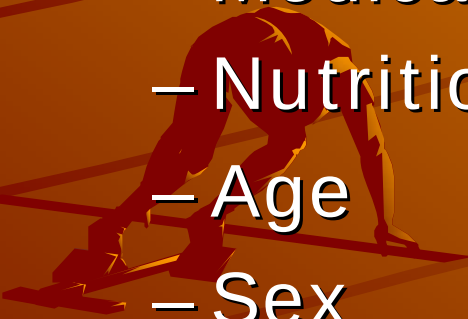
Factors affecting chemical exposure

- ◆ Chemical concentration
- ◆ Type of chemical
- ◆ Route of entry
 - Injection
 - Ingestion
 - Eye and skin absorption
 - Inhalation
- ◆ Duration of exposure

Other factors influencing chemical exposure

◆ Personal habits

- Smoking
- Alcohol consumption
- Medication(s) being used
- Nutrition
- Age
- Sex



Lungs as a route of chemical exposure

- ◆ Extremely vulnerable to chemical agents
- ◆ Chemicals may pass through lungs to blood
- ◆ Some chemicals are odorless and/or colorless
- ◆ Chemicals may not generate immediate effects
- ◆ Can enter respiratory system through punctured ear drums

Eyes and skin as routes of chemical exposure

- ❖ Some chemicals injure skin (corrosive)
- ❖ Some chemicals pass through the skin and into bloodstream and then to vulnerable organs
- ❖ Skin absorption is enhanced by abrasions, cuts, heat, and moisture
- ❖ Chemicals can dissolve in the eye's moist surface and be carried to rest of the body via the bloodstream

Protecting the eyes and skin

- ◆ Wear protective equipment
- ◆ Do not use contact lenses
- ◆ Keep hands away from the face
- ◆ Minimize contact with liquids
- ◆ Minimize contact with solids



Means of ingesting chemicals

- ◆ Direct ingestion

- ◆ Personal habits

- Chewing gum or tobacco
- Drinking
- Eating
- Smoking cigarettes
- Applying cosmetics



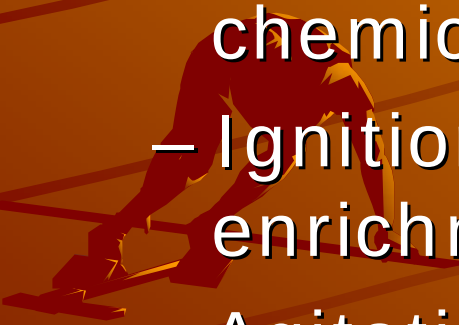
Means of injecting chemicals

- ◆ Stepping on a contaminated object
- ◆ Tripping over a contaminated object
- ◆ Falling on a contaminated object
- ◆ Protecting oneself
 - Wear safety shoes
 - Avoid physical hazards
 - Taking commonsense precautions



Fire and explosion

- ◆ Typical causes of fires and explosions
 - Chemical reactions that produce fire, explosion or heat
 - Ignition of explosive or flammable chemicals
 - Ignition of materials due to oxygen enrichment
 - Agitation of shock or friction sensitive compounds
 - Sudden release of materials under pressure



Fire and explosion (Page 2)

❖ Possible effects

- Intense heat
- Open flame
- Smoke inhalation
- Flying objects
- Release of toxic chemicals



Fire and explosion (Page 3)

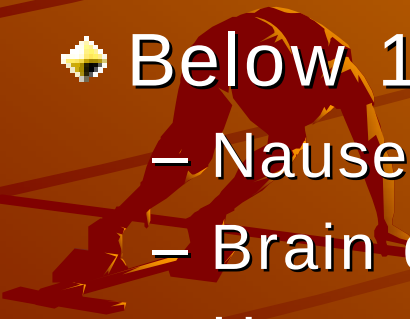
- ◆ May arise spontaneously
- ◆ May occur from
 - Moving drums
 - Accidentally mixing incompatible chemicals
 - Introducing a spark source
- ◆ Can affect both on-site personnel and/or require evacuation of surrounding areas

Protection measures

- ◆ Have qualified personnel monitor for explosive atmospheres and flammable vapors
- ◆ Keep all ignition sources away from an explosive or flammable atmosphere
- ◆ Use non-sparking, explosion-proof equipment
- ◆ Follow safe practices when performing any task that might result in agitation or release of chemicals

Oxygen deficiency

- ◆ Normal oxygen content of air is 21%
- ◆ Physiological effects occur when oxygen decreases below 16%
 - Impaired attention, judgment and coordination
 - Increased breathing and heart rate
- ◆ Below 16%
 - Nausea and vomiting
 - Brain damage
 - Heart damage
 - Unconsciousness



Oxygen deficiency (Page 2)

- ◆ Concentrations of 19.5% and lower are considered to be indicative of an oxygen deficiency
- ◆ Oxygen deficiency may result from
 - Displacement by another gas
 - Consumption of oxygen by a chemical reaction
 - Consumption of oxygen by a biological reaction
- ◆ Low lying areas and confined spaces most vulnerable

Ionizing radiation

❖ Radioactive materials emit three types of harmful radiation

- Alpha
- Beta
- Gamma

❖ Alpha radiation is usually stopped by clothing or the outer layers of skin, but can be hazardous if inhaled or ingested

Ionizing radiation (Page 2)

- ❖ Beta radiation can cause burns to the skin and damage to the subsurface blood system or can be harmful if inhaled or ingested
- ❖ Beta radiation requires protective clothing, scrupulous personal hygiene and decontamination



Ionizing radiation (Page 3)

- ❖ Gamma radiation passes through clothing and human tissue and can cause serious damage to the body
- ❖ Chemical protective suits offer little or no protection, however, respiratory protection keeps the gamma rays from being inhaled



Biologic hazards

- ❖ Waste sources include hospitals, research facilities, medical offices
- ❖ Can be dispersed through water and wind
- ❖ Can occur through poisonous snakes, insects, animals, and plants, and indigenous pathogens
- ❖ Requires thorough washing of exposed body surfaces

Safety/physical hazards

◆ Operations at hazardous waste sites pose these types of hazards and include:

- Holes or ditches
- Precariously positioned objects
- Sharp objects
- Slippery surfaces
- Steep grades
- Uneven terrain
- Unstable surfaces



Safety/physical hazards

(Page 2)

- ◆ Additionally, the function of the work poses these types of hazards
 - Working around heavy equipment
 - Protective equipment can impair ability to work, including agility, mobility, hearing, and vision
- ◆ Accidents can directly injure workers and create additional hazards such as increased chemical exposures, danger of explosion caused by mixing chemicals

Electrical hazards

◆ Exposure sources

- Overhead power lines
- Downed electrical wires
- Buried cables
- Lightning
- Capacitors that retain charges

◆ Use ground fault interruptors on hand held tools and equipment and water-tight corrosion-resistant cables

Heat stress

- ◆ Major hazard when PPE is worn
- ◆ PPE limits the dissipation of body heat and moisture
- ◆ Can occur within 15 minutes of starting work
- ◆ Heat stress early warning signs
 - Rashes
 - Cramps
 - Discomfort
 - Drowsiness



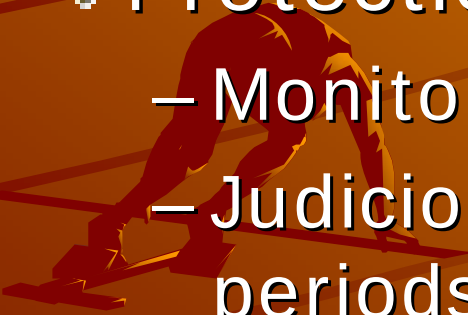
Heat stress (Page 2)

◆ Heat stroke

- Permanent body damage
- Death

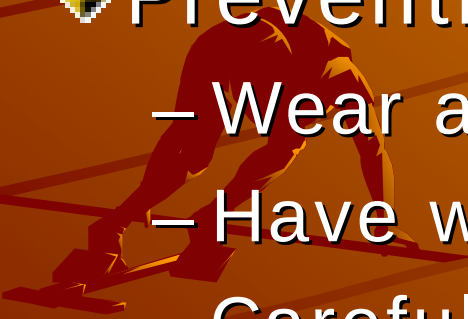
◆ Protections

- Monitoring workers
- Judicious scheduling of work with rest periods
- Replacement of fluids



Cold exposure

- ❖ Cold injury such as frostbite and hypothermia
- ❖ Loss of ability to work
- ❖ Prevention techniques
 - Wear appropriate clothing
 - Have warm shelter readily available
 - Carefully schedule work and rest periods
 - Monitor workers' physical conditions



Noise

- ◆ Work around equipment creates noise
- ◆ Effects include:
 - Workers being startled, annoyed or distracted
 - Physical damage to the ear, pain, and temporary and/or permanent hearing loss
 - Communications interference
- ◆ Excessive noise may require a hearing conservation program as specified under 29 CFR 1910.95 and protective equipment usage

Lesson 3



Planning and organization

Planning and organization

- ◆ Planning is the first and most critical element of a hazardous waste site operation
- ◆ Four important aspects of planning
 - Organizational structure
 - Work plan
 - Site safety plan
 - Coordinating with existing response community
- ◆ Safety meetings and inspections
- ◆ Viewed as an ongoing process in order to adapt to new site conditions and new information



Organizational structure

◆ Developed in the first stage of planning

◆ Structure should:

- Identify a leader who has the authority to direct all activities
- Identify the other personnel needed for the project and assign to them their functions and responsibilities
- Show lines of authority, responsibility and communication
- Identify the interface with the response community



Typical organization structure

- ◆ Consists of both onsite and off-site personnel
- ◆ Onsite personnel include
 - Personnel essential for a safe and efficient response
 - Optional personnel that may be desirable for a large organization where responsibilities can be delegated to a greater number of personnel



Typical organization structure

(Page 2)

- ◆ Optional personnel are those specialists that are called upon for specific tasks, either onsite or off-site
- ◆ Single personnel may perform several tasks required by the response action
- ◆ All response teams should have a Site Safety and Health Officer (SSHO) who has ready access to other occupational health professionals

Typical organization structure

(Page 3)

- ◆ Requires a strong and visible commitment to worker safety at all levels and the safety of the general public
- ◆ Commitment must be from the beginning of the project
- ◆ Close contact and interaction among workers, supervisors and management enabling open communication on safety and other work-related matters
- ◆ A high level of housekeeping, orderly workplace conditions and effective environmental quality control

Typical organization structure

(Page 4)

- ◆ Well-developed selection, job placement and advancement procedures plus other employee support services
- ◆ Training practices emphasizing early indoctrination and follow-up instruction in job safety procedures
- ◆ Added features or variations in conventional safety practices
- ◆ Effective disciplinary plan to encourage employees to adhere to safety practices

Onsite Personnel

- ◆ Project team leader
- ◆ Field team leader
- ◆ Command post supervisor
- ◆ Decontamination station officers
- ◆ Rescue team
- ◆ Site Safety and Health Officer (SSHO)
- ◆ Work party

On site optional personnel

- ◆ Scientific advisor
- ◆ Financial officer
- ◆ Logistics officer
- ◆ Photographer
- ◆ Security officer
- ◆ Public information officer
- ◆ Recordkeeper

Off site personnel

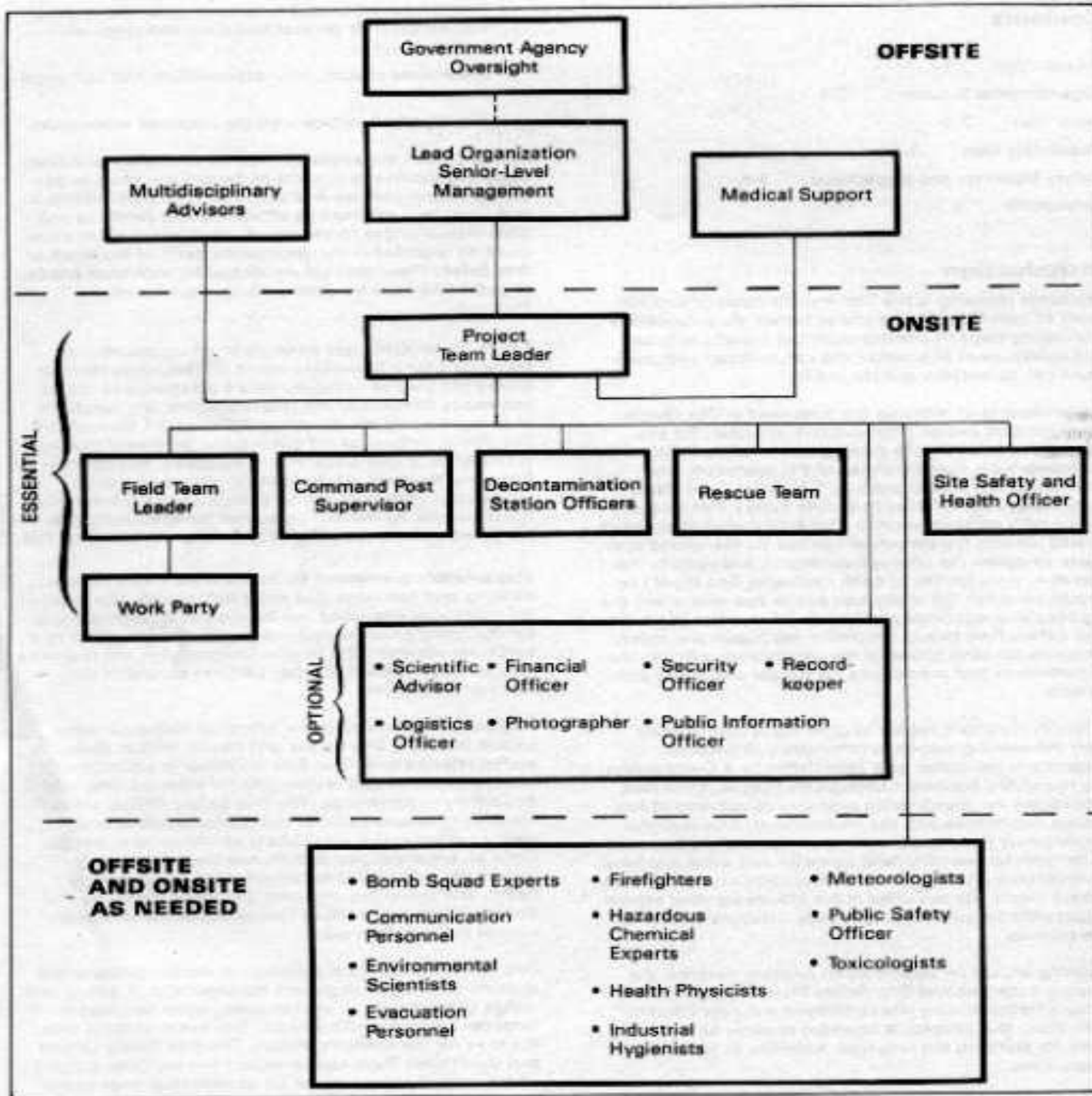
- ◆ Government oversight agency
- ◆ Lead organization senior-level management
- ◆ Multidisciplinary advisors
- ◆ Medical support



Off site and onsite as needed personnel

- ◆ Bomb squad experts
- ◆ Communication personnel
- ◆ Environmental scientists
- ◆ Evacuation personnel
- ◆ Firefighters
- ◆ Hazardous chemical experts
- ◆ Health physicists
- ◆ Industrial hygienists
- ◆ Meteorologists
- ◆ Public safety officer
- ◆ Toxicologists

Typical Organization



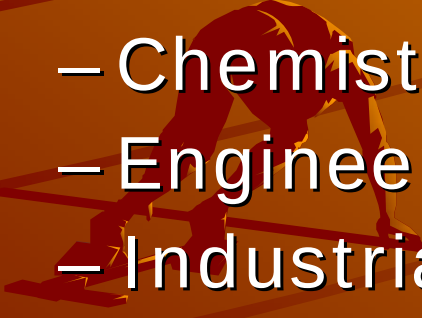
Senior level management responsibilities

- ◆ Provide the necessary facilities, equipment and money
- ◆ Provide adequate personnel and time resources to conduct the activities safely
- ◆ Support the efforts of onsite management
- ◆ Provide appropriate disciplinary action when unsafe acts or practices occur

Multi-disciplinary advisors

◆ Provide advice on the design of the Work Plan and Site Safety Plan

◆ Experts may be from the following areas:

- 
- Chemistry
 - Engineering
 - Industrial hygiene
 - Information
 - Public Relations
 - Radiation health physics
 - Law
 - Medicine
 - Pharmacology
 - Physiology
 - Toxicology

Medical support

- ◆ Become familiar with the types of materials on site, the potential worker exposures, and recommend the medical program for the site
- ◆ Provide emergency treatment and decontamination procedures for the specific type of exposures
- ◆ Obtain special drugs, equipment or supplies necessary to treat exposures
- ◆ Provide emergency treatment procedures appropriate to the other hazards of the site

Project team leader

- ◆ Prepare and organize the background review of the situation, the Work Plan, the Site Safety Plan, and the field team
- ◆ Obtain permission for site access
- ◆ Ensure that the Work Plan is completed and on schedule
- ◆ Briefs the field teams on their specific assignments
- ◆ Use the SSHO to ensure that safety and health requirements are met
- ◆ Prepares the final report
- ◆ Serves as liaison with public officials

SSHO

- Selects protective clothing and equipment
- Periodically inspects protective clothing and equipment
- Ensures that protective clothing and equipment are properly stored and maintained
- Controls entry and exit at Access Control Points
- Coordinates safety and health program with the Scientific advisor
- Confirms each team member's suitability for work based on physician's recommendation

SSHO (Page 2)

- ◆ Monitors the work parties for signs of stress
- ◆ Participates in the preparation of and implements the Site Safety Plan (SSP)
- ◆ Conducts periodic inspections to determine if the SSP is being followed
- ◆ Enforces the buddy system
- ◆ Knows emergency procedures, evacuation routes and important telephone numbers
- ◆ Notifies, when necessary, local public emergency officials
- ◆ Coordinates emergency medical care

Field team leader

- ◆ Manages field operations
- ◆ Executes the Work Plan and schedule
- ◆ Enforces safety procedures
- ◆ Coordinates with the SSHO in determining protection level
- ◆ Enforces site control
- ◆ Documents field activities and sample collection
- ◆ Serves as liaison with public officials

Command post supervisor

- ◆ Notifies emergency response personnel by telephone or radio in the event of an emergency
- ◆ Assists SSHO in a rescue
- ◆ Maintains a log of communication and site activities
- ◆ Assists other field team members in the clean area
- ◆ Maintains line of sight and communication contact with the work parties, via walkie-talkies, radios, signal horns or other means

Decontamination station officer

- ◆ Sets up decontamination lines and decontamination solutions appropriate for the type of chemical contamination on site
- ◆ Controls the decontamination of all equipment, personnel and samples
- ◆ Assists in the disposal of contaminated clothing and materials
- ◆ Ensures that all required equipment is available
- ◆ Advises medical personnel of potential exposures and consequences

Rescue Team

- ◆ Stands by partially dressed in protective gear, near hazardous work areas
- ◆ Rescues any worker whose health or safety is endangered



Work party

- ◆ Safely completes the onsite tasks required to fulfill the Work Plan
- ◆ Complies with the Site Safety Plan
- ◆ Notifies SSHO or supervisor of unsafe conditions



Scientific advisor

❖ Provides advice for:

- Field monitoring
- Sample collection
- Sample analysis
- Scientific studies
- Data interpretation
- Remedial plans



Logistics officer

- ◆ Plans and mobilizes the facilities, materials, and personnel required for the response



Photographer

- ◆ Photographs site conditions
- ◆ Archives photographs



Financial/Contracting officer

- ◆ Provide financial support
- ◆ Provide contractual support



Public information officer

- 
- ◆ Releases information to the news media and the public concerning site activities

Security officer

◆ Manages site security



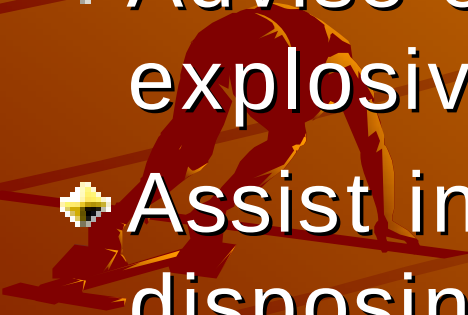
Recordkeeper

- ◆ Maintains the official records of site activities



Bomb Squad Explosion Experts

- ◆ Advise on methods of handling explosive materials
- ◆ Assist in safely detonating or disposing of explosive materials



Communication personnel

- ◆ Provide communication to the public in the event of an emergency
- ◆ Provide communication links for mutual aid



Environmental scientists

- ◆ Predict the movement of released hazardous materials through the atmospheric, geologic and hydrogeologic environment
- ◆ Assess the effect of this movement on air, groundwater and surface water quality
- ◆ Predict the exposure of people and the ecosystem to the hazardous materials

Evacuation personnel

- 
- ◆ Help plan for public evacuation
 - ◆ Mobilize transit equipment
 - ◆ Assist in public evacuation

Firefighters

- 
- ◆ Respond to fires that occur on site
 - ◆ Stand by for response to potential fires
 - ◆ Perform rescue

Hazardous chemical experts

- ◆ Advise on the properties of the materials on site
- ◆ Advise on containment control methods
- ◆ Advise on the dangers of chemical mixtures that may result from site activities
- ◆ Provide immediate advice to those at the scene of a chemical-related emergency

Health physicists

- ◆ Evaluate radiation health hazards and recommend appropriate action



Industrial hygienists

- ◆ Conduct health hazard assessments
- ◆ Advise on adequate health protection
- ◆ Conduct monitoring tests to determine worker exposure to hazardous substances

Meteorologists

◆ Provide meteorological information



Public safety personnel



➡ Control access to the site

Toxicologists

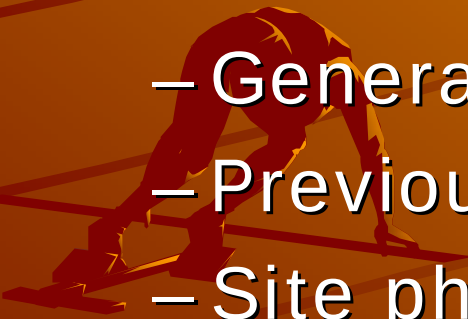
- ◆ Advise on toxicological properties and health effects of substances on site
- ◆ Provide recommendations on protection of worker health

Work Plan

- ◆ Describes the anticipated clean-up activities that must be developed before beginning onsite response actions.
- ◆ The plan should be periodically reexamined and updated as new information about site conditions is obtained
- ◆ Requires a multi-disciplinary approach and may require input from all levels of onsite and off-site management and consultants

Work Plan elements

- ◆ Review available information, including:
 - Site records
 - Waste inventories
 - Generator and transporter manifests
 - Previous sampling and monitoring data
 - Site photos
 - State and local environmental and health agency records



Work Plan elements (Page 2)

- ◆ Define work objectives
- ◆ Determine methods for accomplishing the objectives, such as, sampling plans, inventory and disposal techniques
- ◆ Determine personnel requirements
- ◆ Determine the need for additional training of personnel
- ◆ Determine equipment requirements, including special equipment or services

Site Safety Plan (SSP)

- ◆ Establishes policies and procedures to protect workers and the public from the potential hazards posed by a hazardous waste site
- ◆ Provides measures to minimize accidents and injuries that may occur during normal daily activities or during adverse conditions
- ◆ Ensures that all safety aspects of site operations are thoroughly examined prior to commencing field work

Site Safety Plan (Page 2)

- ◆ Should be modified as needed for every stage of site activity
- ◆ Should involve both onsite and off-site management and be reviewed by occupational and industrial health and safety experts, physicians, chemists, or other appropriate personnel

Site Safety Plan elements

- ◆ Name key personnel and alternates responsible for site safety
- ◆ Describe risks associated with each operation
- ◆ Confirm that personnel are adequately trained to perform their job responsibilities and to handle the specific hazardous situations they may encounter
- ◆ Describe the protective clothing and equipment to be worn by personnel during various site operations
- ◆ Describe any site-specific medical surveillance requirements

Site Safety Plan elements

(Page 2)

- ◆ Describe the program for periodic air monitoring, personnel monitoring and environmental sampling
- ◆ Describe actions to be taken to mitigate existing hazards to make the work environment less hazardous
- ◆ Define site control measures and include a site map
- ◆ Establish decontamination procedures for personnel and equipment

Site Safety Plan Elements (Page 3)

- ◆ Set forth the site's SOP's. These should be:
 - Prepared in advance
 - Based on the best available information, operational principles and technical guidance
 - Field tested by qualified health and safety professionals
 - Appropriate to the types of risk at the site
 - Formulated to be easy to understand and practice
 - Provided in writing to all site personnel
 - Included in training programs for site personnel
- ◆ Set forth a Contingency Plan for safe and effective response to emergencies

Safety meetings and inspections

- ◆ Conducted by the SSHO prior to initiating site activity and before and after each work day
- ◆ SSHO should conduct frequent inspections of site conditions, facilities, equipment and activities to determine whether the SSP is adequate and being followed
- ◆ Minimum frequency of inspections varies with the characteristics of the site and the equipment used on the site

Purposes of site meetings

- ◆ Describe the assigned tasks and their potential hazards
- ◆ Coordinate activities
- ◆ Identify methods and precautions to prevent injuries
- ◆ Plan for emergencies
- ◆ Describe any changes in the SSP
- ◆ Get worker feedback on conditions affecting safety and health
- ◆ Get worker feedback on how well the SSP is working

Changes that prompt changes in SSP

- ◆ Changes in work and other site activities
- ◆ State of degradation of containers and containment structures
- ◆ State of equipment maintenance
- ◆ Weather conditions



Guidelines for conducting inspections

- ◆ Develop a checklist for each site, listing the items that should be inspected
- ◆ Review the results of these inspections with supervisors and workers
- ◆ Reinspect any identified problems to ensure that they have been corrected
- ◆ Document all inspections and subsequent follow-up actions
- ◆ Retain records until site activities are completed and as long as required by regulatory agencies

Factors affecting frequency of inspections

- ◆ The severity of the risk on site
- ◆ Regulatory requirements
- ◆ Operation and maintenance requirements
- ◆ The expected effective lifetime of clothing, equipment, vehicles and other items
- ◆ Recommendations based on professional judgment, laboratory test results and field experience

Lesson 4

SITE EMERGENCIES



Site emergencies

Planning

Personnel

Training

Recognition

Communications

Response equipment

First aid

Safe distances

Security

Evacuation

Decontamination

Mapping

Procedures

Documentation

Site emergencies (Page 2)

- ◆ The nature of work at hazardous wastes sites makes site emergencies a continual possibility
- ◆ Emergencies happen quickly and unexpectedly and require immediate response
- ◆ They may be limited to one worker experiencing heat stress or to an explosion that spreads a toxic chemical cloud

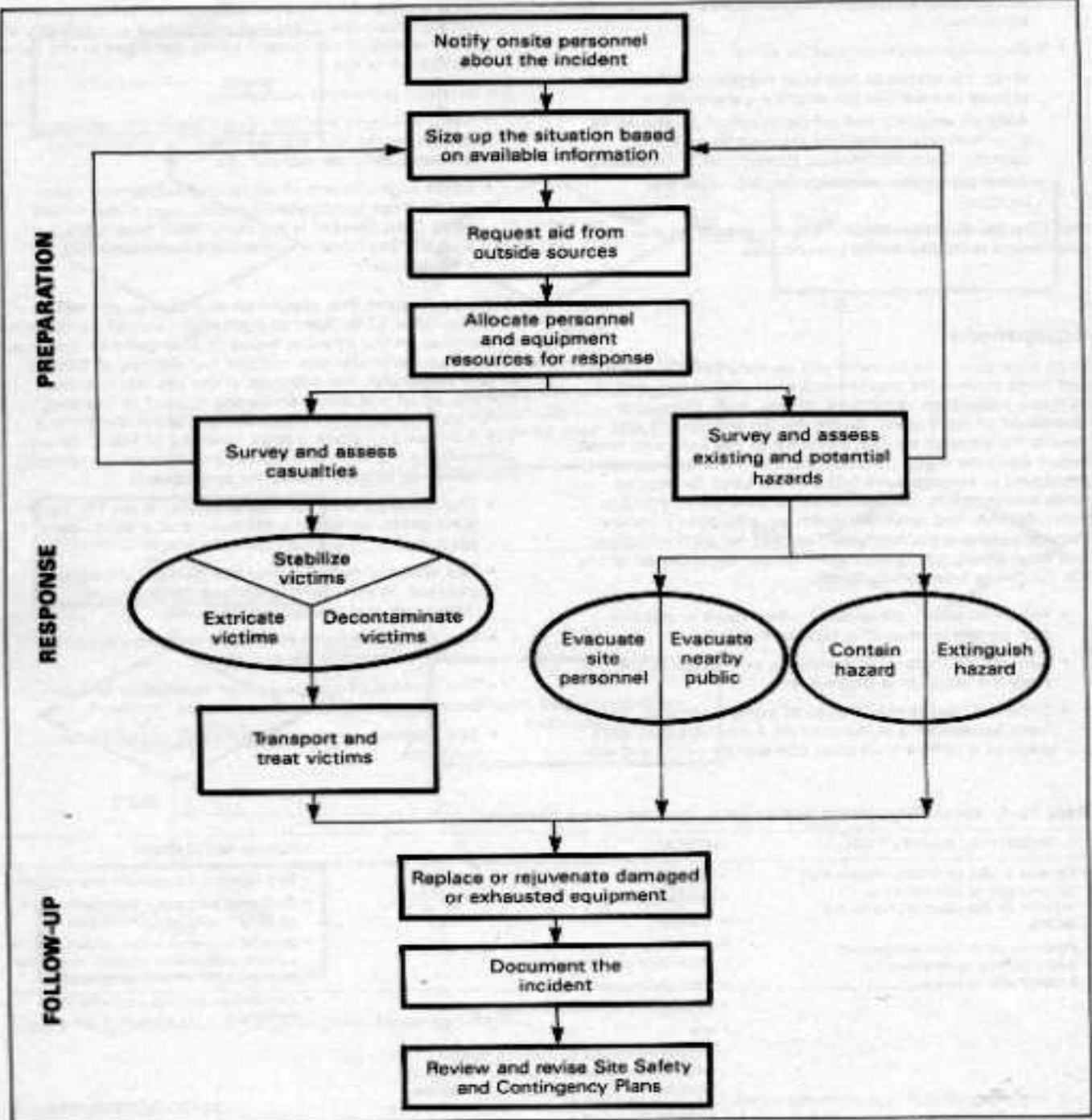
Site emergencies (Page 3)

❖ Potential for complexity

- Uncontrolled toxic chemicals may be numerous and unidentified
- Their effects may be synergistic
- Hazards may potentiate each other
- Rescuers may become victims



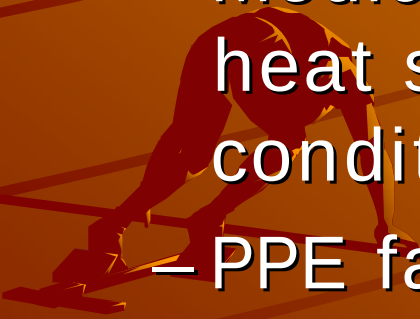
Site emergency operations



Typical site emergencies

❖ Worker-related

- Minor slips, trips and falls
- Chemical exposure
- Medical problems such as heat stress, heat stroke, aggravation of pre-existing conditions
- PPE failure
- Physical injuries
- Electrical burns, shock and electrocution



Typical site emergencies (Page 2)

💎 Waste-related

- Fire
- Explosion
- Leak
- Release of toxic vapors
- Reaction of incompatible chemicals
- Collapse of containers
- Radioactive materials

Planning

- ◆ Decisive action is required when an emergency occurs
- ◆ Rapid choices may have far-reaching effects
- ◆ Delays of minutes can be life-threatening
- ◆ Personnel must be ready to respond
- ◆ Equipment must be on hand and working
- ◆ Contingency plan is essential

Contingency plan

- ◆ Written document that sets forth policies and procedures for responding to an emergency
- ◆ Be designed as a discrete section of the SSP
- ◆ Be compatible with and integrated into pollution response, disaster, fire and emergency plans of government agencies
- ◆ Be rehearsed regularly using drills and mock situations
- ◆ Be reviewed in response to changing or new conditions or information

Contingency plan elements

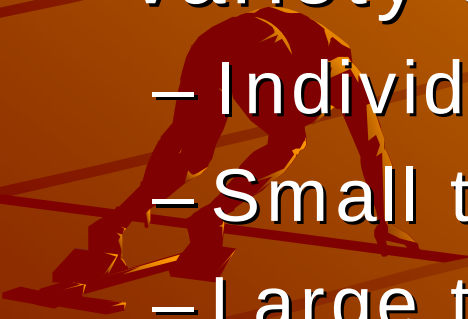
- ◆ Personnel roles, lines of authority, training and communication
- ◆ Site mapping, security and control, safe refuges, evacuation routes, and decontamination stations
- ◆ Medical/first aid
- ◆ Equipment
- ◆ Emergency procedures
- ◆ Documentation
- ◆ Reporting

Response personnel

- ◆ Project team leader
- ◆ SSHO
- ◆ Command post supervisor
- ◆ Rescue team
- ◆ Decontamination station officers
- ◆ 24-hour medical team
- ◆ Communications personnel
- ◆ Environmental scientists
- ◆ Hazardous chemical experts
- ◆ Firefighters
- ◆ Meteorologists
- ◆ Public safety personnel
- ◆ Public evacuation personnel
- ◆ On-scene coordinator

Response personnel (Page 2)

- ◆ Duties are similar to those previously presented under organization section
- ◆ Personnel may be deployed in a variety of ways
 - Individuals located across the site
 - Small teams
 - Large teams
 - Several interacting teams



Response personnel (Page 3)

- ◆ Deployed based on:
 - Nature and scope of work
 - Size of the site
 - Number of personnel needed
 - Number of personnel available
- ◆ Structure should show a clear chain of command that is flexible enough to handle multiple emergencies
- ◆ Every individual should know his/her position and authority

Onsite personnel

- ◆ Contingency plan should identify all individuals and teams who will respond
- ◆ All personnel, whether directly involved in a response, should know their responsibilities in an emergency
- ◆ One person must be able to lead and assume total control and decision making at the site

Onsite leader

- ◆ Be identified in the emergency response plan
- ◆ Be backed up by a specified alternate
- ◆ Have the authority to resolve all disputes about health and safety
- ◆ Be authorized to seek and purchase supplies
- ◆ Have control over activities of everyone entering the site
- ◆ Have the clear support of management

Onsite teams

- ◆ Teams provide greater efficiency and safety

- ◆ May be created for specific tasks

 - Decontamination

 - Fire fighting

 - Rescue

 - Containment

 - Entry

- ◆ At large sites should remain just outside the EZ and partially dressed to make an immediate entrance, if required

- ◆ Capable of first aid and CPR

Offsite personnel

- ❖ May include experts and representatives of groups from local, state and federal organizations offering response, rescue and/or support
- ❖ Should be identified and secured during the advance planning stage



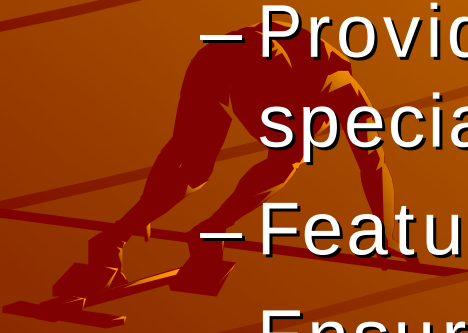
Planning for offsite personnel

- ◆ Make arrangement with individual experts
- ◆ Make arrangements with appropriate agencies
- ◆ Alert these authorities to the types of emergencies that may occur
- ◆ Determine their estimated response time
- ◆ Identify backup facilities
- ◆ Provide training and information about the hazards
- ◆ Establish a contact person and a means of notification

Training

◆ Training program should:

- Relate directly to site-specific, anticipated situations
- Be brief and repeated often
- Provide an opportunity to practice special skills
- Feature drills frequently
- Ensure that training records are kept

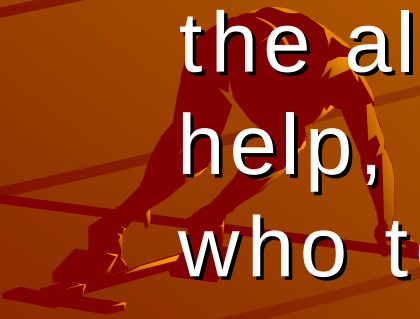


Training (Page 2)

- ◆ Everyone entering the site should be made aware of the hazards and hazardous actions
- ◆ Visitors should be briefed on basic emergency procedures
- ◆ Personnel without defined roles should be trained as well
- ◆ Personnel on emergency teams should have a thorough understanding of emergency response

Non-emergency personnel training

- ◆ Hazard recognition
- ◆ SOPs
- ◆ Signaling during an emergency: the alarm used, how to summon help, what information to give and who to give it to
- ◆ Evacuation routes and safe refuges
- ◆ The person or station to report to when the alarm sounds



Emergency personnel training

- ◆ Emergency chain of command
- ◆ Communications methods and signals
- ◆ How to call for help
- ◆ Emergency equipment and its use
- ◆ Emergency evacuation while wearing PPE
- ◆ Removing injured personnel
- ◆ Offsite support and how to use it
- ◆ Certification in first aid/CPR
- ◆ Recognizing and treating chemical and physical injuries
- ◆ Recognizing and treating heat and cold stress

Offsite personnel training

- ◆ How to recognize and deal with onsite hazards
- ◆ Knowledge of site-specific hazards
- ◆ Appropriate response techniques
- ◆ Site emergency procedures
- ◆ Decontamination procedures

Emergency recognition and prevention

- ◆ Be alert on a day to day basis for potential hazardous situations
- ◆ Be aware if signs and symptoms in themselves and others that warn of hazardous conditions and exposure
- ◆ Attend a daily before work briefing to discuss coming day activities
- ◆ Attend an after work debriefing to review work accomplished and problems observed

Before work briefing

- ◆ Tasks to be performed
- ◆ Time constraints of work
- ◆ Hazards that may be encountered
- ◆ How to recognize symptoms
- ◆ Concentration limits
- ◆ Effects of the potential hazards
- ◆ Emergency procedures

Communications

- ❖ Crucial messages must be conveyed during an emergency
- ❖ Information such as the location of injured personnel, orders to evacuate, and blocked evacuation routes must be transmitted
- ❖ Outside support services must be reached
- ❖ The public notified, if necessary
- ❖ Internal signals should be developed and rehearsed daily
- ❖ External communications systems and procedures should be clear and accessible to workers

Internal communications

◆ Used to:

- Alert workers to danger
- Convey safety information
- Maintain site control

◆ Any effective system may be used

◆ The primary system must have a backup

◆ Must be:

- Clearly understood by all personnel
- Checked and practiced daily
- Intrinsically safe (spark-free)

Emergency Signals

- ◆ Different from ordinary signals
- ◆ Brief and exact
- ◆ Limited in number
- ◆ Examples:
 - Noisemakers (horns, bells)
 - ◆ One long blast – evacuate
 - ◆ 2 short blasts – localized problem
 - ◆ 2 long blasts – all clear

Emergency Signals (Page 2)

- ❖ Background noise will interfere with talking and listening
- ❖ Wearing PPE will impede hearing and limit vision
- ❖ Inexperienced radio users may need practice speaking clearly



Offsite communication

- ◆ National Response Center (NRC) 1-800-424-8802 should be contacted in the event of a significant chemical release
- ◆ All personnel must be familiar with the notification protocol
- ◆ If there is no onsite telephone system, all personnel must know the location of the nearest phone
- ◆ A supply of telephone change and the necessary phone numbers must be available for public phone use

Site mapping

- ◆ Detailed information about the site is essential for advanced planning
- ◆ A site map is a valuable tool
- ◆ It can be the same one as developed for the SSP, but it should focus on potential areas where emergencies may occur
- ◆ Pins and colored flags can be used to locate personnel deployment, hazard areas and equipment locations
- ◆ When an emergency occurs, its location should be pinpointed on the map
- ◆ During an emergency, current and forecasted weather conditions should be added

Site map elements

- ◆ Hazard areas, especially potential IDLH conditions
- ◆ Site terrain, topography, buildings, barriers
- ◆ Evacuation routes
- ◆ Site accessibility by land, sea and air
- ◆ Work crew locations
- ◆ Changes in work activities, vandalism, accidents
- ◆ Offsite populations or environments at risk

Safe distances

- ◆ Safe distances can only be determined at the time of the emergency
- ◆ Some reference material exists to assist in determining these



Factors affecting safe distances

- ◆ Toxicological properties of the substance
- ◆ Physical state of the substance
- ◆ Quantity released and the method, height and rate of release
- ◆ Vapor pressure of the substance
- ◆ Vapor density relative to air
- ◆ Wind speed and direction
- ◆ Atmospheric stability
- ◆ Air temperature and temperature change with altitude
- ◆ Local topography

Public evacuation

- ◆ Site management should plan for this in coordination with the appropriate local, state and federal agencies
- ◆ Should be practiced annually via a table top exercise



Safe refuges

- ◆ Can be set up for local emergencies that do not require site evacuation
- ◆ Can be used for:
 - Short rest breaks
 - Emergency response strategy meetings
 - Temporary relief from heat
- ◆ Should be located in a relatively safe along the upwind fence line or on the periphery of the EZ

Safe refuge supplies

- ◆ A sitting/resting area
- ◆ Water for decon
- ◆ Wind indicator
- ◆ Communication system
- ◆ First aid supplies
- ◆ Special monitoring devices
- ◆ Bolt cutters
- ◆ Fire extinguishers
- ◆ Hand tools

SZ safe refuges

- ◆ Can be set up in the support zone or offsite in the case of a site-wide evacuation

- ◆ Provide for:

- First aid for injured personnel

- Clean dry clothing

- Wash water to treat chemical exposure victims

- Communication with the command post



SZ safe refuge supplies

- ◆ Decon supplies
- ◆ Oxygen and/or air
- ◆ Water
- ◆ Special testing equipment
- ◆ First aid supplies
- ◆ Communication system

Site security and control

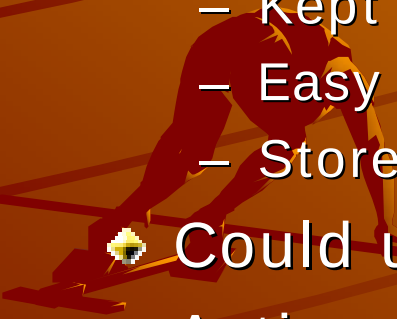
- ◆ In an emergency, the project team leader must know who is onsite and must be able to control the entry of personnel into the hazardous areas
- ◆ One control method is the use of checkpoints
- ◆ Checkpoints can be set up to prevent entry into either of the three zones
- ◆ Should have a checkpoint control manager assigned to each location

Checkpoint information

- ◆ Name and affiliation
- ◆ Status: coming in or out of site
- ◆ Time of entry
- ◆ Anticipated exit time
- ◆ Zones entered
- ◆ Team or “buddy”
- ◆ Task being performed
- ◆ PPE worn
- ◆ Rescue and response equipment used

Personal locator system

- ◆ Need to rapidly locate where personnel are and who may be injured during an emergency
- ◆ Could use a passive system
 - Graphic
 - Roughly drawn to scale and visible landmarks included
 - Kept current
 - Easy to locate board
 - Stored outside the EZ, preferably at the in the SZ
- ◆ Could use site map with flags or colored pins
- ◆ Active systems are worn by site personnel and are activated by flipping switches or a fall



Evacuation routes

- ❖ Fires or explosion may cut off workers from the normal exit near the command post
- ❖ Alternate routes should be established in advance, marked and kept clear
- ❖ Routes should be directed from:
 - EZ through an upwind CRZ to the SZ then to an offsite location

Evacuation guidelines

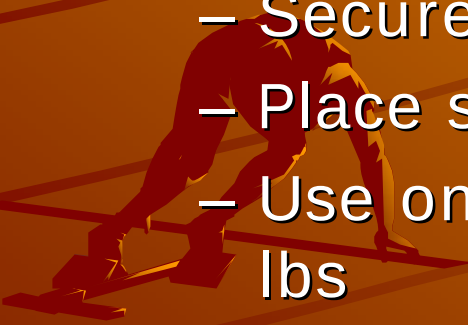
- ◆ Place the evacuation routes in the predominantly upwind direction of the EZ
- ◆ Run the evacuation routes through the CRZ
- ◆ Consider the accessibility potential of routes
- ◆ Develop two or more routes that lead to safe areas and that are separate or remote from each other
- ◆ Mark routes “safe” or “not safe” on a daily basis
- ◆ Mark routes with materials such as barricade tape, flagging or traffic cones

Evacuation guidelines (Page 2)

◆ Consider the mobility constraints of personnel wearing PPE

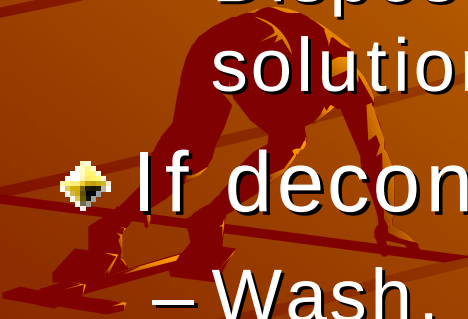
- Place ladders across any cut or excavation more than 3' deep
- Provide ladders for rapid descent
- Secure ladders to prevent slipping
- Place standard cleated ramps across ditches
- Use only ladders capable of supporting 250 lbs
- Check the clearance of access ports
- Check toe and body clearance of ladders

◆ Make escape routes known to all who go on site



Emergency decontamination

- ◆ Develop procedures to :
 - Decon victim
 - Protect medical personnel
 - Dispose of contaminated PPE and wash solutions
- ◆ If decon can be performed:
 - Wash, rinse, and/or cut off protective clothing and equipment



Emergency decontamination

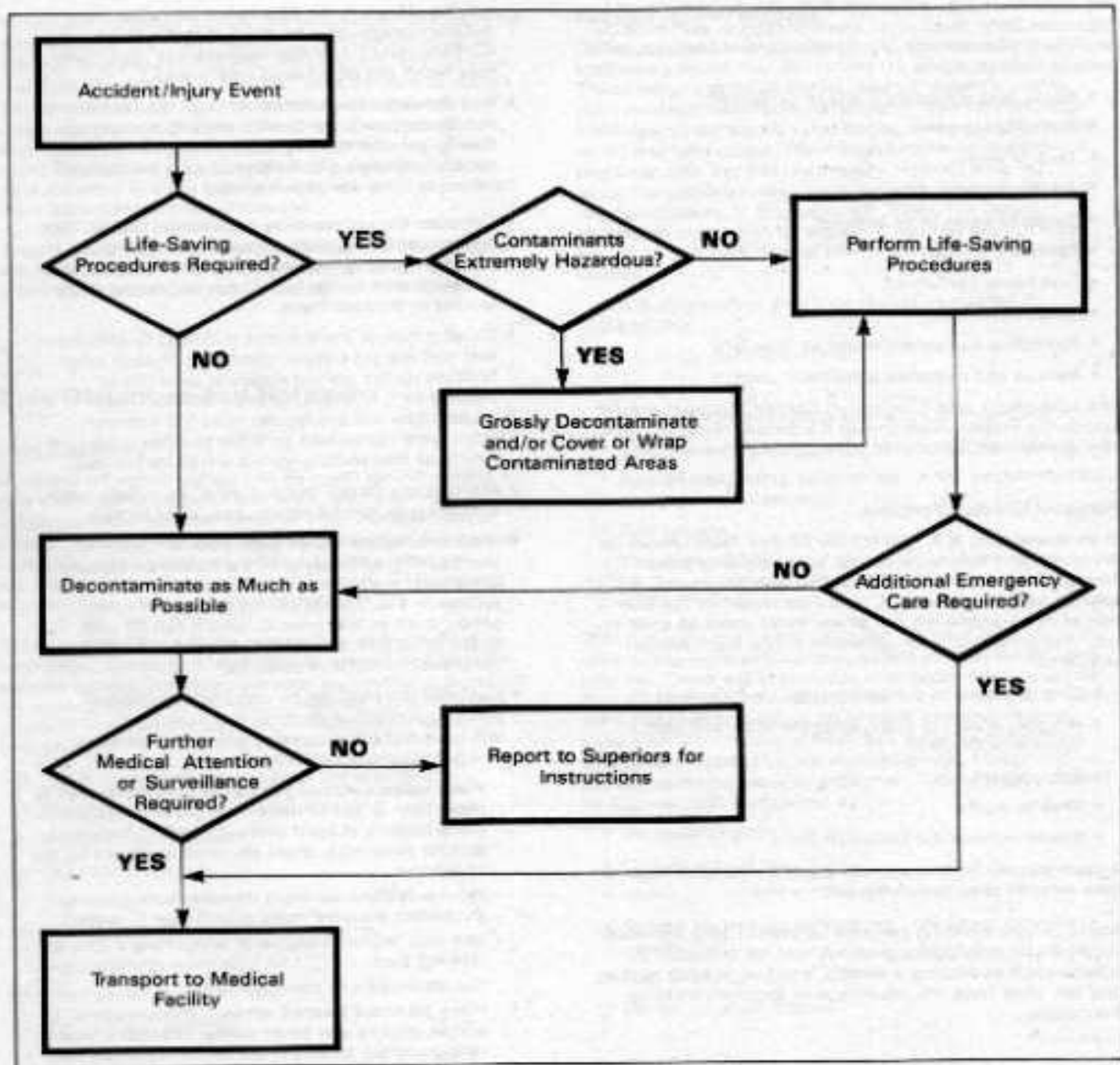
(Page 2)

◆ If decon cannot be performed:

- Wrap the victim in blankets, plastic or rubber
- Alert emergency and offsite medical personnel to potential contamination
- Instruct medical personnel about specific decon procedures
- Send along onsite personnel familiar with the incident
- Send along victim's medical records



Emergency decon decision chart



Emergency equipment

- ❖ In an emergency, equipment will be necessary:
 - To rescue and treat victims
 - To protect response personnel
 - To mitigate hazardous conditions on site
- ❖ Some regular equipment can double for emergency equipment
- ❖ All equipment should be in working order, fueled and available for an emergency
- ❖ Provide safe and unobstructed access for emergency and firefighting equipment at all times

Emergency personal protection equipment

- ◆ Escape SCBA or SCBA which can be brought to the victim to replace or supplement victim's unit
- ◆ PPE specialized for the known site hazards

Emergency medical equipment

- ◆ Air splints
- ◆ Antiseptics
- ◆ Blankets
- ◆ Decon solution for specific chemical hazard
- ◆ Emergency eye wash, shower and wash station
- ◆ Ice
- ◆ Reference books
- ◆ Resuscitator
- ◆ Safety harness
- ◆ Stretchers
- ◆ Water in portable containers
- ◆ Wire basket litter

Emergency mitigation equipment

- ◆ Fire fighting equipment and supplies
- ◆ Spill containment supplies, such as absorbents, booms
- ◆ Special hazardous use tools, such as spark-free tools
- ◆ Containers to hold contaminated materials
- ◆ Heavy equipment, as needed

Emergency equipment work procedures

- ◆ Refuel heavy equipment when there is $\frac{1}{2}$ or $\frac{1}{3}$ left in the tank
- ◆ Require all equipment repairs to take place when the problem occurs
- ◆ Separate two similar pieces of equipment; park each at a different spot and do not use them at the same time
- ◆ Refill all empty SCBAs immediately
- ◆ Stock higher levels and quantities of protective clothing than is required for anticipated hazards

Special equipment factors

- ◆ Types of emergencies that may arise
- ◆ Types of hazards to site personnel and the appropriate containment, mitigative and protective measures
- ◆ Capabilities and estimated response times of offsite emergency personnel
- ◆ Number of site personnel who may be victims
- ◆ Probable number of personnel available for response

Emergency medical treatment

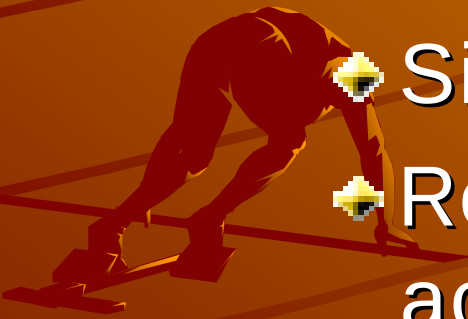
- ◆ Toxic exposures and hazardous instances will vary from site to site
- ◆ Medical treatment may range from bandaging minor cuts and abrasions to life-saving techniques
- ◆ Train onsite personnel in on-the-spot treatment techniques
- ◆ Establish and maintain telephone contact with medical experts
- ◆ Establish liaisons with local hospitals and ambulances

Key points for medical treatment

- ◆ Train a cadre of personnel in first aid and CPR and make it thorough, frequent and geared to site-specific hazards
- ◆ Establish liaison with local medical personnel and educate them about site-specific hazards
- ◆ Set up onsite emergency first aid stations and see that they are well supplied and restocked after use

Emergency response procedures

- ◆ Notification
- ◆ Size up
- ◆ Rescue/response actions
- ◆ Follow-up



Notification

- ◆ Alert personnel to the emergency
 - Notify personnel
 - Stop work activities if necessary
 - Lower background noise
 - Begin emergency procedures



Essential notification information

- ◆ What happened
- ◆ Where it happened
- ◆ Whom it happened to
- ◆ When it happened
- ◆ How it happened
- ◆ The extent of damage
- ◆ What aid is needed
- ◆ The extent of injuries

Size-up

◆ Determine:

– What happened

◆ Type of incident

◆ Cause of incident

◆ Extent of chemical release and transport

◆ Extent of damage to structures, equipment, etc.

– Casualties

◆ Victims (number, location and condition)

◆ Treatment required

◆ Missing personnel



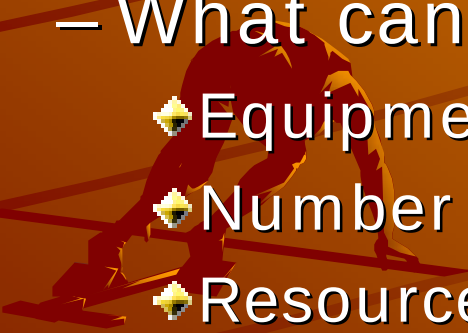
Size-up (Page 2)

– What could happen, consider:

- ◆ Types of chemicals in site
- ◆ Potential for fire, explosion, release
- ◆ Location of all personnel relative to area
- ◆ Potential for danger to offsite populations

– What can be done, consider:

- ◆ Equipment and personnel resources needed
- ◆ Number of uninjured personnel available on site
- ◆ Resources on site
- ◆ Resources available from outside groups
- ◆ Response time for outside groups
- ◆ Hazards involved in rescue and response



Rescue/response actions

- ◆ The type of action should be decided on and the necessary steps implemented based on available information
- ◆ Some actions may occur concurrently
- ◆ No one should attempt rescue and response until proper backup and evacuation routes have been identified



Type of actions

- ◆ Enforce the buddy system

- ◆ Survey casualties:

- Locate all victims and assess their condition
- Determine resources needed for stabilization and transport

- ◆ Assess existing and potential hazards to site personnel and to offsite populations. Determine:

- Whether and how to respond
- The need for evacuation
- Resources needed for evacuation and response

Type of actions (Page 2)

- ◆ Allocate resources: onsite personnel and equipment
- ◆ Request aid from offsite agencies
- ◆ Control: bring the hazardous situation under complete or temporary control
- ◆ Use measures to prevent the spread
- ◆ Extricate: remove or assist victims from the area
- ◆ Decontaminate: use established decon procedures to decon uninjured personnel in the CRZ or establish a new decon area

Type of actions (Page 3)

- ◆ Stabilize: administer any medical procedures that are necessary before the victims can be moved
- ◆ Attend to what caused the emergency and anything damaged or endangered by it
- ◆ Transport: take measures to minimize chemical contamination of the transport vehicle and ambulance and hospital personnel
- ◆ Adequately protect rescuers from decon operations or cover victims in sheeting

Type of actions (Page 4)

◆ Evacuate:

- Move site personnel to a safe distance upwind of incident
- Monitor incident for significant changes
- Inform public safety personnel when there is a potential or actual need to evacuate the offsite population
- Do not attempt large-scale evacuation, let the government implement and control it

Follow-up

- ◆ Prepare to handle another emergency, if and when it happens, before resuming site work
- ◆ Notify government agencies as required
- ◆ Restock all equipment and supplies expended; replace or repair damaged equipment and refuel vehicles
- ◆ Review and revise all aspects of the Contingency Plan as necessary including new site conditions and lessons learned

Information needed to revise contingency plan

- ◆ Cause: What caused the emergency?
- ◆ Prevention: Was it preventable? How?
- ◆ Procedures: Were they adequate? Were wrong actions the result of bad judgment, wrong or insufficient information, or poor procedures? Can procedures and training be improved?
- ◆ Site profile: How does the incident affect the site profile? How are other cleanup activities affected?
- ◆ Community: How is the community safety affected?
- ◆ Liability: Who is liable for damages?

Documentation

- ◆ Project team leader should initiate an investigation and documentation of the incident
- ◆ Especially important where workers are killed or injured, property has been damaged or it resulted in damage to the surrounding environment
- ◆ May be used to:
 - Avert recurrence of the incident
 - As evidence in future legal actions
 - For assessment of liability by insurance companies
 - Reviewed by government agencies

Types of documentation

- ✦ Written transcripts taken from tape recordings made during the emergency
- ✦ Bound logbooks
- ✦ Eyewitness accounts

Documents must

- ◆ Be accurate and objective
- ◆ Authentic using a chain of custody procedure, each person making the entry must sign and date the entry
- ◆ Nothing should be erased
- ◆ Use a horizontal line to denote where his/her entries begin and end

Completeness of documents

- ◆ Chronological history of the incident
- ◆ Facts about the incident and when they became available
- ◆ Title and names of personnel; composition of teams
- ◆ Actions; decisions made and by whom; orders given: to whom, by whom and when; actions taken: who did what, when, where and how
- ◆ Types of samples and test results; air monitoring results
- ◆ Possible exposures of site personnel
- ◆ History of injuries or illnesses during or as a result of the emergency

Lesson 5

SITE CHARACTERIZATION



Site characterization phases

- ◆ Conduct offsite characterization before site visit
 - Gather information away from the site
 - Perform site perimeter reconnaissance
- ◆ Conduct onsite surveys
- ◆ Once operations begin, perform ongoing monitoring to provide continuous source of information about site conditions



Site characterization (Page 2)

- ◆ It is a continuous process
- ◆ As information is obtained in one phase, it is used to develop the health and safety plan for the next phase
- ◆ Informal information gathering continues as site personnel discover new information

Offsite characterization

- ◆ Interview/records research
- ◆ Perimeter reconnaissance
- ◆ Used to determine protective equipment required for personnel entry
- ◆ Must consider the proposed work



Interview/records search

- ◆ Exact location of the site
- ◆ Detailed description of the activities that have occurred at the site
- ◆ Duration and timing of activities
- ◆ Meteorologic data
- ◆ Terrain
- ◆ Geologic and hydrogeologic data
- ◆ Habitation – population centers, population at risk

Interview/records search (Page 2)

- ◆ Accessibility by air and roads
- ◆ Pathways of dispersion
- ◆ Present status of any response activities
- ◆ Hazardous substances involved, their chemical and physical properties
- ◆ Previous surveying, sampling and monitoring data

Hazardous substance information sources

- ◆ Company records, receipts, logbooks, etc.
- ◆ Records from regulatory agencies
- ◆ Interviews with current and past personnel
- ◆ Generator and transporter records
- ◆ Water and sewer records
- ◆ Interviews with nearby residents
- ◆ Local fire and police records
- ◆ County records
- ◆ Utility company records
- ◆ Media reports

Perimeter reconnaissance

- ◆ Develop a preliminary site map showing pits, ponds, impoundments, containers, buildings and tanks
- ◆ Review historical and current aerial photos
- ◆ Note any labels, markings or placards on containers or vehicles
- ◆ Note the amount of deterioration or damage of containers or vehicles
- ◆ Note any biologic indicators, such as dead animals, plants, etc.

Perimeter reconnaissance (Page 2)

- ◆ Note any unusual conditions, such as vapor clouds, discolored soil, oil slicks, vapors, etc.
- ◆ Monitor the ambient air for toxic substances, combustible and flammable gases or vapors, oxygen deficiency, ionizing radiation
- ◆ Note any unusual odors
- ◆ Collect and analyze offsite soil and water samples

Visible indicators of potential IDLH and other dangerous conditions

- ◆ Large containers or tanks that must be entered
- ◆ Enclosed spaces
- ◆ Potentially explosive or flammable situations
- ◆ Extremely hazardous materials
- ◆ Visible vapor clouds
- ◆ Areas where biological indicators are located

Aerial photo review

- ◆ Disappearance of natural depressions, quarries, pits
- ◆ Variation in reforestation of disturbed areas
- ◆ Mounding or uplift in disturbed areas or paved surfaces
- ◆ Modifications in grade
- ◆ Changes in vegetation around buildings
- ◆ Changes in traffic patterns at site

Onsite survey

- ◆ Purpose is to verify and supplement information already gathered
- ◆ Priorities should be established for hazard assessment and site activities after careful evaluation of probable conditions
- ◆ Entry teams should at least include four team members, two for entry and two for support and rescue

Upon entry

- ◆ Monitor the air for IDLH and other conditions that may cause death or serious injury
- ◆ Monitor for ionizing radiation
- ◆ Visually observe for signs of actual or potential IDLH or other dangerous conditions
- ◆ Potential signs would indicate to proceed with caution or leave area

Onsite survey activities

- ◆ Conduct further air monitoring
- ◆ Note types of containers, impoundments, or other storage systems
- ◆ Note the condition of waste containers and storage systems
- ◆ Note the physical conditions of the materials
- ◆ Identify natural wind barriers: buildings, hills, tanks

Onsite survey activities

(Page 2)

- ◆ Determine the potential pathways of dispersion
- ◆ Use remote sensing to locate buried wastes or containers
- ◆ Note any indicators of potential exposure
- ◆ Note any safety hazards
- ◆ Identify reactive, incompatible, flammable or highly corrosive materials

Onsite survey activities

(Page 3)

- ◆ Note the presence of any potential naturally occurring skin irritants: poison ivy, oak and sumac
- ◆ Note any tags, labels, markings, etc.
- ◆ Collect samples
- ◆ Sample for or otherwise identify the following:
 - Biologic or pathologic hazards
 - Radiologic hazards

Indicators of atmospheric hazards

◆ Explosive atmosphere

– Combustible gas meter

- ◆ <10%LEL: Continue investigation
- ◆ 10%-25% LEL: Continue onsite monitoring
- ◆ >25% LEL: Explosion hazard, leave site

◆ Oxygen level

– Oxygen meter

- ◆ <19.5%: Wear SCBA or other positive pressure
- ◆ 19.5-25%: Continue with caution
- ◆ >25%: Fire and explosion hazard

Indicators of atmospheric hazards (Page 2)

◆ Radiation

- Radiation survey meter

- ◆ < 2 mrem/hr: Proceed with caution, possible hazard
- ◆ > 2 mrem./hr: Radiation hazard

◆ Inorganic/organic gases and vapors

- Colorimetric tubes, chemical-specific testing

- ◆ Chemical specific references needed

◆ Organic gases and vapors

- Organic vapor analyzer, portable photoionizer

- ◆ Chemical-specific references needed

Types of containers

- ◆ Paper or wood packages
- ◆ Metal or plastic barrels or drums
- ◆ Underground tanks
- ◆ Above ground tanks
- ◆ Compressed gas cylinders
- ◆ Pits, ponds, lagoons
- ◆ Other

Condition of containers

- ◆ Sound and undamaged
- ◆ Visibly rusted or corroded
- ◆ Leaking
- ◆ Bulging
- ◆ Types and quantities of material in containers
- ◆ Labels on containers indicating corrosive, explosive, reactive, flammable, radioactive, toxic (Cannot always trust these)

Physical condition of materials

- ◆ Gas, liquid or solid
- ◆ Color and turbidity
- ◆ Behavior: corroding, foaming or vaporizing
- ◆ Conditions conducive to splash or contact



Potential pathways

◆ Air

◆ Biologic routes: animals, food chain

◆ Groundwater

◆ Land surface

◆ Surface water



Remote sensing devices

- ◆ Electromagnetic resistivity
- ◆ Seismic refraction
- ◆ Magnetometry
- ◆ Metal detection
- ◆ Ground penetrating radar



Indicators of potential exposure

- ◆ Dead fish, animals, plants
- ◆ Dust or spray in the air
- ◆ Fissures or cracks in solid surfaces that expose deep waste layers
- ◆ Pools of liquid
- ◆ Foams or oils on liquid surfaces
- ◆ Gas generation or effervescence
- ◆ Deteriorating containers
- ◆ Cleared land areas or possible landfilled areas

Safety hazards to note

- ◆ Conditions of site structures
- ◆ Obstacles to entry or exit
- ◆ Terrain homogeneity
- ◆ Terrain stability
- ◆ Stability of stacked materials



Samples to collect

- ◆ Air
- ◆ Drainage ditches
- ◆ Soil, surface and subsurface
- ◆ Standing pools of liquids
- ◆ Storage containers
- ◆ Streams and ponds
- ◆ Groundwater, upgradient, beneath site and down gradient

Information documentation

- ◆ Ensures accurate communication
- ◆ Ensures the quality of the data
- ◆ Provide the rationale for safety decisions
- ◆ Substantiating possible legal actions
- ◆ Recording information pertinent to:
 - Field activities
 - Sample analysis
 - Site conditions

Information documentation (Page 2)

- ◆ Documents should be controlled
- ◆ Field personnel should record all onsite activities and observations in a logbook
- ◆ Photographs can be an accurate, objective addition to written observations and should be listed in either the field logbook or a separate logbook
- ◆ Sample labels should be serially numbered
- ◆ Labels should be firmly affixed to the sample containers

Documentation

- ◆ Logbooks
- ◆ Field data records
- ◆ Graphs
- ◆ Photographs
- ◆ Sample labels
- ◆ Chain of custody forms
- ◆ Analytical records

Documentation control elements

- ◆ Each document should be numbered with a unique number
- ◆ List each document in an inventory
- ◆ Record the whereabouts of each document in a document register, including the name and location of the person holding the document
- ◆ Collect all documents at the end of each work period
- ◆ Make sure that all entries are made in waterproof ink
- ◆ File all documents in a central file at the completion of the site response

Typical logbook entries

- ◆ Date and time of entry
- ◆ Purpose of sampling
- ◆ Name, address, and affiliation of personnel sampling
- ◆ Name and address of the material's producer
- ◆ Type of material
- ◆ Description of material container
- ◆ Description of sample
- ◆ Chemical components and concentrations
- ◆ Number and size of samples taken

Typical logbook entries (Page 2)

- ◆ Description and location of the sampling point
- ◆ Date and time of sample collection
- ◆ Difficulties experienced in obtaining samples
- ◆ Visual references, such as maps and photographs of the sampling site
- ◆ Field observations: weather conditions
- ◆ Field measurements: explosiveness, pH
- ◆ Chain of custody form completion

Photograph elements

- ◆ Date, time and name of site
- ◆ Name of the photographer
- ◆ Location of the subject within the site
- ◆ General compass direction of the orientation of the photo
- ◆ General description of the subject
- ◆ Sequential number of the photograph and film roll number
- ◆ Camera, lens, and film type used

Sample label requirements

- ◆ The unique sample log number
- ◆ Date and time that the sample was collected
- ◆ Source of the sample: name, location and type of sample
- ◆ Preservative added
- ◆ Analysis required
- ◆ Name of collector
- ◆ Pertinent filed data
- ◆ Use waterproof ink

Hazard assessment

◆ Once the presence and concentrations of hazardous substances identified

◆ Key parameters

- Threshold Limit Value (TLV)
- Permissible Exposure Limits (PEL)
- Recommended Exposure Limits (REL)
- IDLH concentrations
- Potential skin absorption and irritation
- Potential eye irritation
- Explosive and flammability ranges



Assessment reference data

- ◆ Inhalation of airborne contaminants
 - TLV, TLV-TWA, TLV-STEL, TLV-C, PEL, REL, IDLH
- ◆ Dermal absorption
 - ACGIH – skin
- ◆ Carcinogens
 - TLV, PEL, REL
- ◆ Noise
 - TLV, PEL, REL
- ◆ Ionizing Radiation
 - PEL
- ◆ Explosion
 - LEL, UEL
- ◆ Fire
 - Flash point

Need for reassessment

- ◆ Commencement of new work phase
- ◆ Change in job tasks
- ◆ Change in season
- ◆ Change in weather
- ◆ Change in ambient levels of contaminants

Lesson 6

SITE CONTROL



Site control

◆ Purposes

- Minimize potential contamination of workers
- Protect the public from the site's hazards
- Prevent vandalism

◆ Especially important in emergency situations

◆ Degree necessary depends upon site characteristics, site size, and the surrounding community

◆ Established in the planning stages and modified based on new information and site assessments

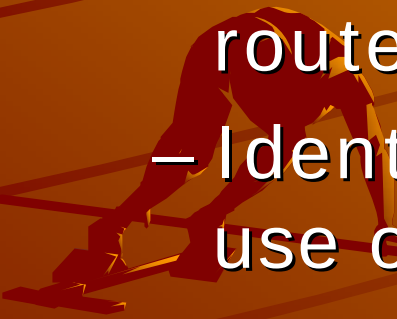
Site control steps

- ◆ Compile a site map
- ◆ Prepare the site for subsequent activities
- ◆ Establish work zones
- ◆ Use the buddy system when necessary
- ◆ Establish and strictly enforce decontamination procedures for equipment and personnel
- ◆ Establish the security measures
- ◆ Set up communications network
- ◆ Enforce safe work practices

Site map

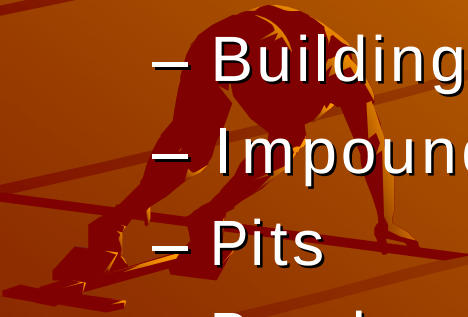
◆ Useful in:

- Planning activities
- Assigning personnel
- Identifying access routes, evacuation routes, and problem areas
- Identifying areas of the site that require use of PPE
- Supplementing the daily safety and health briefings of the field teams



Site map elements

- ◆ Topographic features
- ◆ Prevailing wind direction
- ◆ Site drainage
- ◆ Location of:
 - Buildings
 - Impoundments
 - Pits
 - Ponds
 - Tanks



Revising site map

◆ Revise site map after:

- Accidents
- Changes in site activities
- Emergencies
- Uncovering hazards not previously identified
- New materials on site
- Vandalism
- Weather conditions



Site preparation

- ◆ Time and effort must be spent to ensure that response operations go smoothly and that worker safety is protected
- ◆ Site preparation can be as hazardous as site cleanup
- ◆ Safety measures should be the same as for a cleanup

Site preparation steps

- ◆ Construct roadway to provide ease of access
- ◆ Arrange traffic flow patterns to ensure safe and efficient operations
- ◆ Eliminate physical hazards from the work area as much as possible
 - Ignition sources
 - Exposed and ungrounded wiring
 - Sharp or protruding edges
 - Debris, holes, loose steps, slippery surfaces, etc.
 - Unsecured objects
 - Debris and weeds

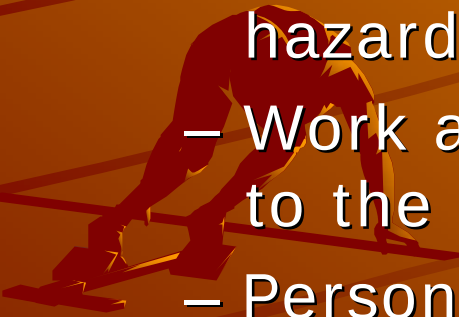


Site preparation steps (Page 2)

- ◆ Install skid-resistant strips on slippery surfaces
- ◆ Construct operation pads
- ◆ Construct loading docks, processing and staging areas and decon pads
- ◆ Provide adequate illumination
- ◆ Install wiring to meet codes

Work Zones

- ◆ To reduce the accidental spread of hazardous substances by workers from the contamination area to the clean area
- ◆ Ensures that:
 - Personnel are properly protected against the hazards present where they are working
 - Work activities and contamination are confined to the appropriate area
 - Personnel can be located and evacuated in an emergency

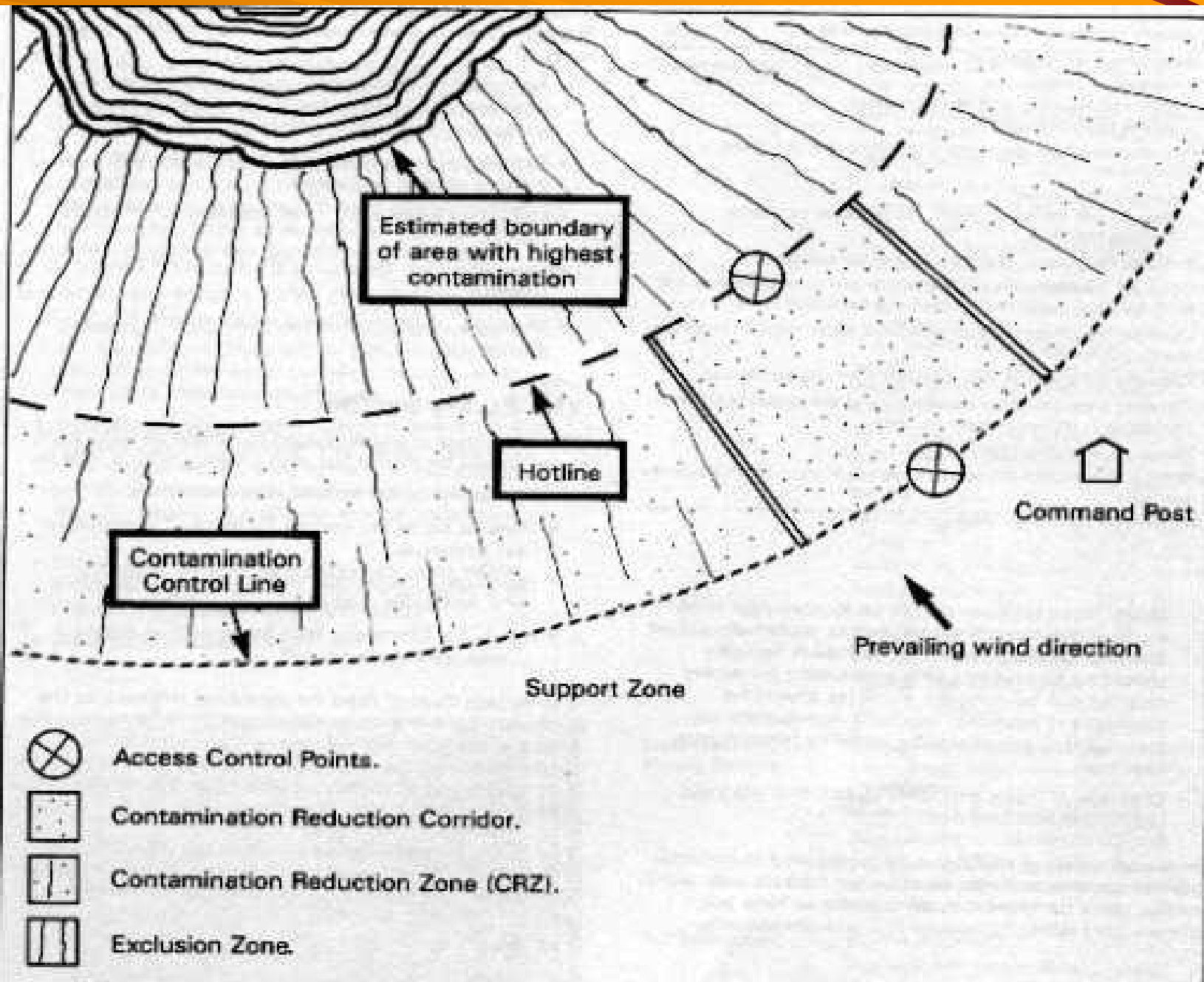


Site work zones

- ◆ Exclusion zone (EZ)
 - The contaminant area
- ◆ Contamination reduction zone (CRZ)
 - The area where decon takes place
- ◆ Support zone (SZ)
 - The uncontaminated area where workers should not be exposed to hazardous conditions



Typical site zones



Exclusion zone (EZ)

◆ Primary activities:

- Site characterization, such as mapping, photographing and sampling
- Installation of wells for groundwater monitoring
- Cleanup work, such as drum movement, drum staging and materials bulking



Exclusion zone (Page 2)

- ◆ Outer line is called the Hotline
 - Should be clearly marked by lines, placards, hazard tape and/or signs
 - Enclosed by a physical barrier such as chains, fences or ropes
- ◆ Access control points should be established to regulate the flow of equipment and personnel into and out of the zone and to help verify that proper procedures for entering and exiting the zone are followed



Exclusion zone (Page 3)

- ◆ Exclusion zone can be divided into different areas of contamination based on known or expected type and degree of hazard
- ◆ All personnel, in exclusion zone should wear PPE as required by SSP
- ◆ Different levels of PPE can be used in zone, depending upon the degree of hazard present

Personnel in exclusion zone

- ◆ Field team leader
- ◆ Work parties
- ◆ Specialized personnel such as heavy equipment operators



Establishing the Hotline

- ◆ Visually survey the immediate environs
- ◆ Determine the locations of
 - Hazardous substances
 - Drainage, leachate and spilled material
 - Visible discolorations
- ◆ Evaluate data from the initial site survey
 - Combustible gases
 - Organic and inorganic gases, particulates or vapors
 - Ionizing radiation

Establishing the Hotline (Page 2)

- ◆ Evaluate the results of soil and water sampling
- ◆ Consider the distance needed to prevent an explosion or fire affecting personnel outside the EZ
- ◆ Consider the distances that personnel must travel to and from the EZ
- ◆ Consider the physical area necessary for site operations
- ◆ Consider meteorological conditions
- ◆ Secure or mark the hotline
- ◆ Modify its location as more information becomes available

Contamination reduction zone

- ◆ Transition area between contaminated area and clean area
- ◆ Designed to reduce the probability that the clean support zone will become contaminated or affected by other site hazards
- ◆ The distance of the CRZ and the decon operations in the CRZ limits the physical transfer of hazardous substances
- ◆ The degree of contamination in the CRZ reduces as the distance from the EZ lengthens

CRZ (Page 2)

- ◆ The decontamination activities occur in the CRZ in the contamination reduction corridor (CRC).
- ◆ Decon begins at the Hotline and has two lines, one for personnel and one for equipment
- ◆ The boundary between the SZ and the CRZ is called the contamination control line
- ◆ Access to the CRZ from the SZ is via access points
- ◆ Personnel entering the CRZ should wear PPE prescribed for the CRZ

CRZ design

- ◆ Facilitate decontamination of equipment, personnel, decontamination station operations personnel and samples
- ◆ Facilitate emergency response
 - Transport of victims
 - First aid equipment
 - Containment equipment
- ◆ Facilitate sample packaging and preparation for onsite and offsite labs



CRZ design (Page 2)

◆ Facilitate equipment resupply

- Air tank changes
- PPE
- Sampling equipment
- Tools

◆ Facilitate worker temporary rest area:

- Toilet facilities
- Benches, chairs, liquids and shade

◆ Drainage of water and other liquids that are used for decon

Support Zones

- ◆ Location of the administrative and other support functions needed to keep the operation running smoothly
- ◆ Personnel may wear work clothes
- ◆ SZ personnel are responsible for alerting the proper agency of an emergency



SZ design

◆ Accessibility:

- Topography
- Available open space
- Location of highways and railroad tracks
- Ease of access for emergency vehicles

◆ Resources:

- Adequate roads, power lines, telephone, shelter and water

SZ design (Page 2)

◆ Visibility:

- Line of sight to EZ

◆ Wind direction:

- Upwind of the EZ

◆ Distance:

- As far from the EZ as practicable



SZ activities

- ◆ Command post
- ◆ Medical station
- ◆ Equipment and supply centers
- ◆ Administration
- ◆ Field laboratory



Command post

- ◆ Supervision of all field activities and teams
- ◆ Maintenance of communications
- ◆ Recordkeeping
 - Accident reports
 - Chain of custody forms
 - Daily logbooks
 - Manifest directories
 - Medical records
 - Personnel training records
 - Site inventories
 - Site safety map
 - SSP

Command post (Page 2)

- ◆ Providing access to up to date safety and health manuals and other reference materials
- ◆ Interfacing with public agencies, medical personnel, the media and others
- ◆ Monitoring work schedules and weather changes
- ◆ Maintaining site security
- ◆ Sanitary facilities

Medical station

- ◆ First aid administration
- ◆ Medical emergency response
- ◆ Medical monitoring activities
- ◆ Sanitary facilities

Equipment/supply centers

- ◆ Supply, maintenance and repair of communications, respiratory and sampling equipment
- ◆ Maintenance and repair of vehicles
- ◆ Replacement of expendable supplies
- ◆ Storage of monitoring equipment and supplies

Administration

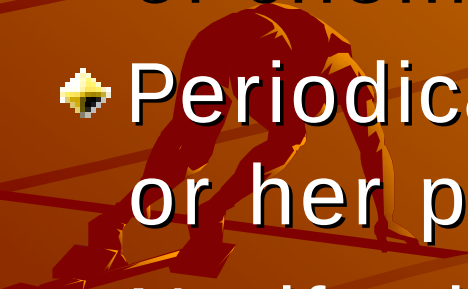
- ◆ Sample shipment
- ◆ Interface with home office
- ◆ Maintenance of emergency telephone numbers, evacuation route maps and vehicle keys
- ◆ Coordination with transporters, disposal sites, and appropriate governmental agencies

Field lab

- ◆ Coordination and processing of environmental and hazardous waste samples
- ◆ Packaging of materials for analysis following the deconning of the outside of the sample containers
- ◆ Maintenance and storage of lab notebooks while in use and in the command post when not in use

The buddy system

- ◆ Provide his or her partner with assistance
- ◆ Observe his or her partner for signs of chemical or heat exposure
- ◆ Periodically check the integrity of his or her partner's PPE
- ◆ Notify the command post supervisors or others of an emergency



Site security

◆ Necessary to:

- Prevent the exposure of unauthorized, unprotected people to the site hazards
- Avoid the increased hazards from vandals or persons seeking to abandon other wastes on the site
- Prevent theft
- Avoid interference with safe working practices



Maintaining site security during work hours

- ◆ Maintain security in the SZ and at access control points
- ◆ Establish an identification system to identify authorized personnel
- ◆ Assign responsibility for enforcing authority for entry and exit
- ◆ Erect a fence or other physical barrier
- ◆ Post signs around the perimeter and use guards to patrol
- ◆ Have the project team leader approve all visitors to the site

Maintaining site security during off-duty hours

- ◆ Assign trained in-house technicians for site surveillance
- ◆ Use security guards to patrol the site boundary
- ◆ Enlist public enforcement agencies
- ◆ Secure the equipment

Communications

◆ Internal communications

- Alert team members to emergencies
- Pass along safety information
- Communicate changes in work
- Maintain site control

◆ External communications

- Coordinate emergency response
- Report to management
- Maintain contact with essential offsite personnel
- Primary external is radio and telephone

Internal communications

- ◆ Verbal communication at a site can be impeded by onsite background noise and PPE
- ◆ Requires identification of individual workers so that commands can reach the right ones
- ◆ Flags may be used to locate personnel in areas where visibility is poor or obstructed
- ◆ Use proper equipment in explosive environments

Internal communication devices

- ◆ Radio: citizen's band, FM, walkie-talkies

- ◆ Noisemakers:

 - Compressed air horn, bell, megaphone, siren, whistle

- ◆ Visual signals

 - Flags, flares, smoke, hand signals, lights, signal board, whole body movements

Safe work practices

- ◆ To maintain a strong safety awareness and enforce safe work procedures
- ◆ Standing orders should:
 - Be distributed to everyone who enters site
 - Posted conspicuously at the Command Post
 - Posted conspicuously at the access points
 - Reviewed by the field team leader with the crew at the beginning of each work day
- ◆ Have material safety data sheets available and brief employees on chemical hazards they face
- ◆ Handle tools and equipment properly

Typical CRZ standing orders

- ❖ No smoking, eating, drinking or application of cosmetics in the CRZ
- ❖ No matches or lighters in the CRZ
- ❖ Check in at the entrance access point before you enter CRZ
- ❖ Check out at the exit access point when you leave the CRZ

Typical EZ standing orders

- ❖ No smoking, eating, drinking or application of cosmetics in the EZ
- ❖ No matches or lighters in the EZ
- ❖ Check in at the entrance access point before you enter EZ
- ❖ Check out at the exit access point when you leave the EZ
- ❖ Always have your buddy with you in the EZ
- ❖ Wear an SCBA in the EZ, if required
- ❖ Exit immediately upon evidence of radioactivity, explosivity or other dangerous conditions and notify supervisor

Precautions to preclude injuries

- ◆ Train personnel in proper operating procedures
- ◆ Install appropriate equipment guards and engineering controls on tools and equipment
- ◆ Provide equipment with appropriate warning signs and labels
- ◆ Use equipment and tools that are intrinsically safe
- ◆ Provide ground fault interrupters and keep portable electric tools and appliances out of explosion areas, unless they are explosion proof

Precautions (Page 2)

- ◆ Use fire-resistant fluid in hydraulic power tools
- ◆ Inspect brakes, hydraulic lines, light signals, fire extinguishers, fluid levels, steering and splash protection at the start of each work day
- ◆ Keep all non-essential personnel out of work area
- ◆ Keep cabs free of all non-essential items and secure loose items
- ◆ Prohibit loose-fitting clothing and loose long hair around moving equipment
- ◆ Do not exceed the rated load capacity of a vehicle or ladders

Precautions (Page 3)

- ◆ Instruct equipment operators to report to their supervisor(s) any abnormalities such as equipment failure, oozing liquids, unusual odors
- ◆ Have a signalman direct backing vehicles
- ◆ All onsite internal combustion engines should have spark arrestors
- ◆ Lower all blades and buckets to the ground and set parking brakes before shutting off vehicles
- ◆ Implement an ongoing maintenance program
- ◆ Store tools in clean, secure areas
- ◆ Keep all heavy equipment used in the EZ in the EZ unless decontaminated

Lesson 7

PERSONAL PROTECTIVE EQUIPMENT (PPE)



PPE

- ◆ Developing a PPE program
- ◆ Selection of respiratory protection equipment
- ◆ Selection of protective clothing and accessories
- ◆ Selection of ensembles
- ◆ PPE use
- ◆ Heat stress and other physiological factors

Developing a PPE program

- ◆ Anyone entering a hazardous waste site must be protected against potential hazards
- ◆ Careful selection and use should protect:
 - Respiratory system
 - Eyes
 - Skin
 - Face
 - Hands and feet
 - Head
 - Body
 - Hearing



OSHA PPE requirements

- ◆ General: 29 CFR 1910.132, 29 CFR 1910.100, 29 CFR 1910.1001-1045
- ◆ Eye and face: 29 CFR 1910.133(a)
- ◆ Noise exposures: 29 CFR 1910.95
- ◆ Head: 29 CFR 1910.135
- ◆ Respiratory: 29 CFR 1910.134
- ◆ Foot: 29 CFR 1910.136
- ◆ Electrical protective devices: 29 CFR 1910.137



Hazards created by PPE

- ◆ Heat stress
- ◆ Limited and impaired vision
- ◆ Limited communication capability
- ◆ Physical and psychological stress
- ◆ Limited mobility
- ◆ Greater the level of PPE, greater the associated risks
- ◆ Over-protection and under-protection can be hazardous and should be avoided

Written PPE program

- ◆ Established for all sites
- ◆ PPE should be only one part of worker protection
- ◆ Objectives of written program:
 - Protect wearer from safety and health hazards
 - Prevent injury to the wearer from incorrect use and/or malfunction of PPE



PPE program elements

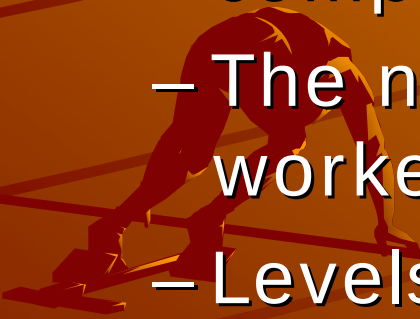
- ◆ Hazard identification
- ◆ Medical monitoring
- ◆ Environmental surveillance
- ◆ Selection, use, maintenance and decontamination of PPE
- ◆ Policy statements
- ◆ Procedures
- ◆ Guidelines
- ◆ Copies should be made available to all employees, along with copies of technical data, maintenance manuals, and regulations

PPE program review

- ◆ Conducted annually

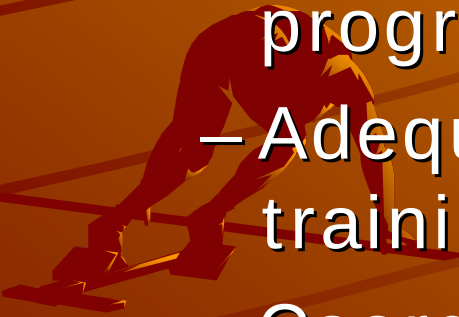
- ◆ Include:

- Survey of each site to ensure compliance
- The number of persons-hours that workers wear various ensembles
- Levels of exposure
- Adequacy of equipment selection
- Adequacy of operational guidelines



PPE program review (Page 2)

- Adequacy of decon, cleaning, inspection, maintenance and storage programs
- Adequacy and effectiveness of training and fitting programs
- Coordination with overall safety and health program elements



PPE program review (Page 3)

- The degree of fulfillment of program objectives
- The adequacy of program records
- Recommendations for program improvement and modification
- Program costs
- ◆ Present results to top management in order to implement necessary changes

Respiratory equipment

- ❖ Written program required by 29 CFR 1910.134
- ❖ Inhalation is a primary route of exposure to chemicals
- ❖ Respirators consist of a face piece connected to either an air source or an air purifying device

Types of respirators

- ◆ Self contained breathing apparatus (SCBA) where the user carries the air supply
- ◆ Supplied air respirators (SAR) where air is supplied from a source located a distance from the user and is connected to the user by an air-line hose.
- ◆ Air purifying respirators (APR) do not have a separate air source but purify ambient air through a filtering element prior to inhalation; may also be powered (PAPR) using a continuous flow of ambient air through filters

Types of respirators (Page 2)

◆ Additional classifications

- Positive pressure respirators maintain a positive pressure in the facepiece during both inhalation and exhalation.

- ◆ Pressure demand where a pressure regulator and an exhalation valve maintain pressure, except during high breathing rates; if a leak develops a continuous flow of air is supplied

- ◆ Continuous flow where a continuous flow of air is supplied at all times, but uses more air than a pressure demand system



Types of respirators (Page 3)

- Negative pressure respirators draw air into the facepiece via the negative pressure created by user inhalation; if they leak, the user draws in contaminated air

◆ Types of facepieces

- Full-facepiece masks cover the face from the hairline to below the chin
- Half-face masks cover the face from below the chin to over the nose and do not provide eye protection



Types of respirators (Page 4)

- ◆ All respirators must be approved by the Mine Safety and Health Administration (MSHA) or NIOSH with testing procedures detailed in 30 CFR Part 11

SCBAs

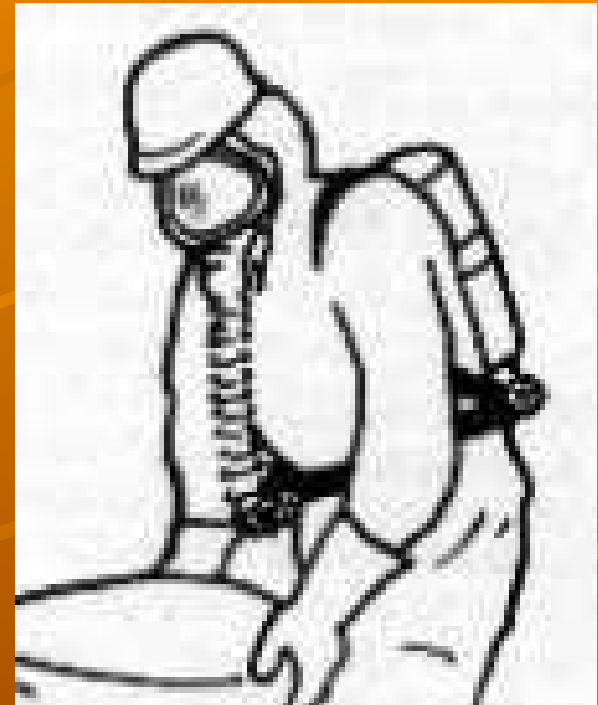
- ◆ Consist of a facepiece, a hose, a regulator and an air source carried by worker

- ◆ Advantages

- Provides the highest available protection against IDLH and most contaminants
- Provides the highest available protection for strenuous work

- ◆ Disadvantages

- Bulky and heavy, 35 lbs and increased likelihood of heat stress
- Finite air supply
- May impair movement in confined areas



SCBAs (Page 2)

◆ Questions when considering SCBAs

- Is the atmosphere IDLH or likely to become it?

- ◆ Yes, use SCBA or a positive pressure SAR with an escape SCBA

- Is the duration of air supply sufficient for accomplishing the necessary tasks?

- ◆ No, use a larger cylinder or a different type of respirator



SCBAs (Page 3)

- Will the bulk and weight of the SCBA interfere with task performance or cause unnecessary stress?

- ◆ Yes, use a SAR

- Will temperature effects compromise respirator effectiveness or cause added stress in the worker?

- ◆ Yes, shorten work period or wait for temperatures to change

- ◆ Compressed gas cylinders must meet minimum US DOT and OSHA requirements and breathing air must meet ANSI standards



Types of SCBAs

- ◆ Open circuit SCBA
- ◆ Closed-circuit SCBA
- ◆ Escape-only SCBA



Open circuit SCBA

- ◆ Supplies clean air to the wearer from a cylinder; wearer exhales to atmosphere
- ◆ Advantages
 - Provide the highest protection
 - A warning alarm signals when 20-25% of the air supply remains
- ◆ Disadvantage
 - Shorter operating time (30-60 minutes)
 - Heavy and bulky
- ◆ Operating time varies depending upon the individual, size of the air tank and task



Closed-circuit SCBA

- ◆ Recycle exhaled gases by removing carbon dioxide with an alkaline scrubber and replenishing the consumed oxygen from a liquid or gaseous source
- ◆ Advantages
 - Longer operating time (up to 4 hours)
 - A warning alarm signals when 20-25% remain
 - Oxygen source is depleted before carbon dioxide scrubber material

Closed-circuit SCBA (Page 2)

❖ Disadvantages

- At very cold temperatures, efficiency may be reduced
- Units retain heat normally exchanged in exhalation and generate heat in scrubber
- When worn outside encapsulating suit, the breathing bag may be permeated by chemical

❖ Not certifiable as a positive pressure unit and not recommended at hazardous waste sites

Escape-only SCBA

- ✦ Supplies clean air to the wearer from either an air cylinder or from an oxygen generating chemical
- ✦ Advantages
 - Lightweight (10 lbs), low bulk, easy to carry
 - Available in pressure demand or continuous flow
- ✦ Disadvantages
 - Cannot be used for entry
 - Provides only 5-15 minutes of respiratory protection



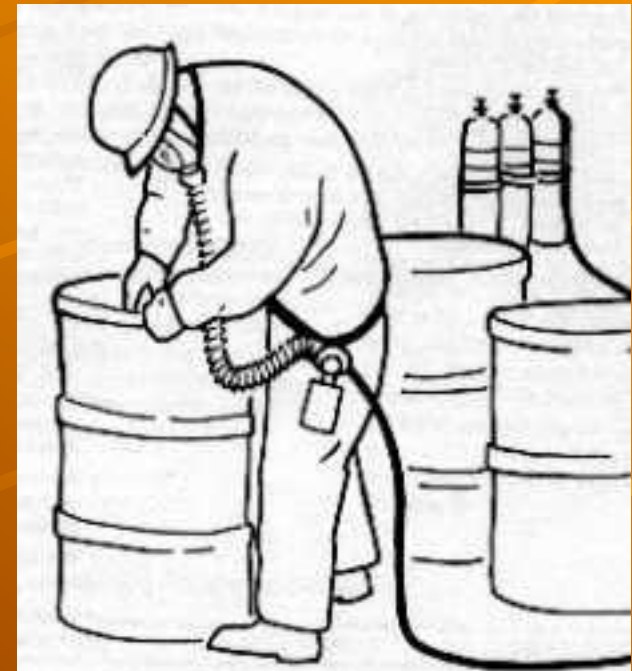
Supplied air respirator

Advantages

- Less bulky than a SCBA
- Protects against most airborne contaminants

Disadvantages

- Not approved for IDLH without an escape SCBA
- Impairs mobility
- Hose length limited to 300'
- As the hose length increases, minimum flow to facepiece decreases
- Air line may be damaged
- Worker must retrace steps to leave work area
- Requires supervision and monitoring of air line



SAR (Page 2)

- ◆ Supply air, never oxygen, to a facepiece via a supply line from a stationary source
- ◆ Air source may be compressed gas cylinders or a compressor that purifies and delivers breathable air to the facepiece
- ◆ Onsite compressors are regulated by OSHA at 29 CFR 1910.134(d)

Questions for SAR use

- ◆ Is the atmosphere IDLH or likely to become it?
 - Yes, use SCBA or add an escape SCBA
- ◆ Will the hose significantly impair worker mobility?
 - Yes, modify the work task or use a different respirator
- ◆ Is there a danger of the air line being damaged or obstructed, or permeated and/or degraded by chemicals?
 - Yes, either the hazard should be removed or use another type of respirator

SAR questions (Page 2)

- ◆ If a compressor is the air source, is it possible for airborne contaminants to enter the air system?
 - Yes, identify the contaminants, use efficient filters and/or absorbents
 - No, Use either air cylinders or a different type of respirator
- ◆ Can other workers and vehicles that might interfere with the air line be kept away?
 - No, use a different type of respirator

Air purifying respirator

❖ Consist of a facepiece and an air purifying device

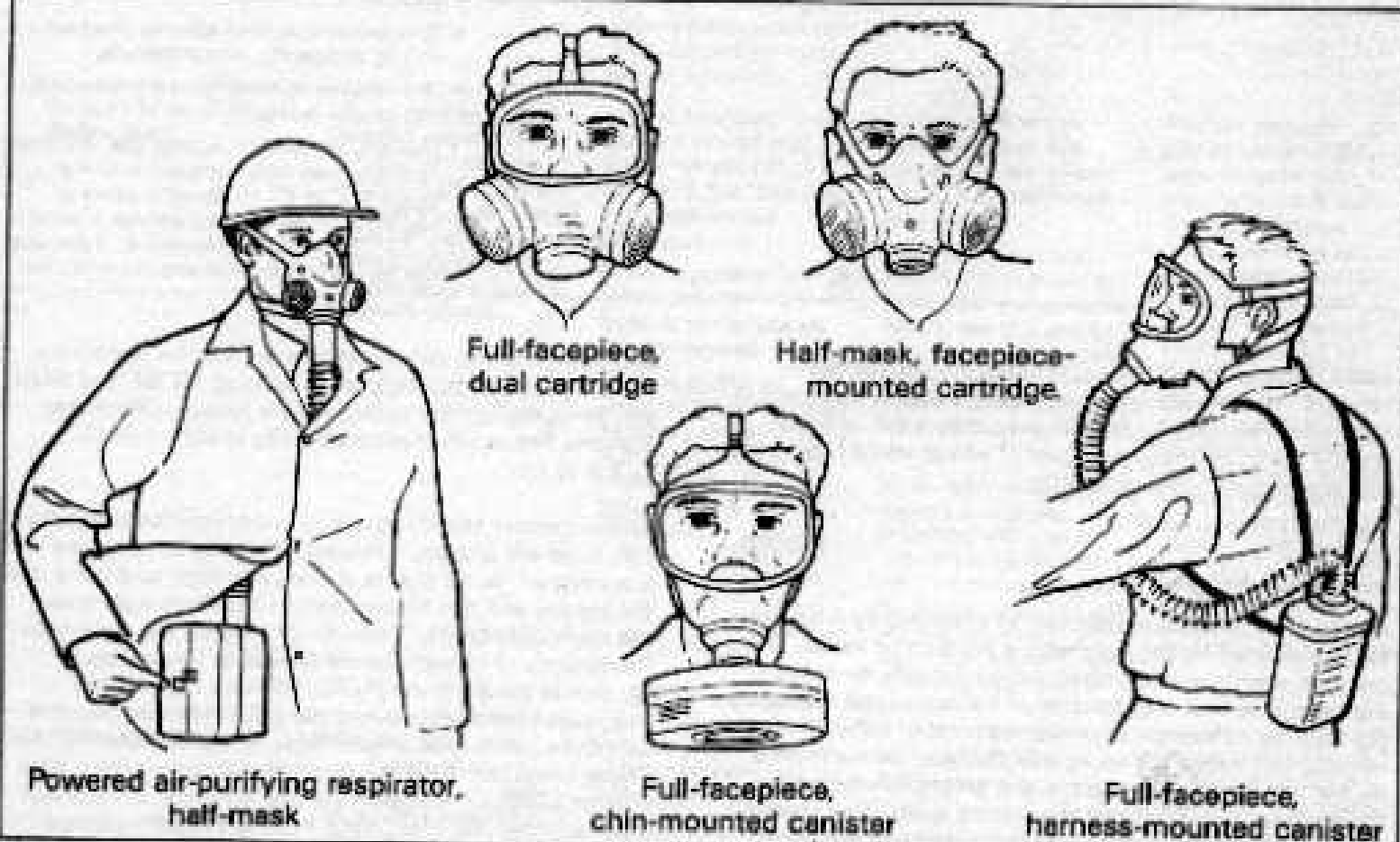
❖ Advantages

- Enhanced mobility
- Light weight

❖ Disadvantages

- Cannot be used in IDLH
- Cannot be used in oxygen deficient atmosphere
- Limited duration of protection
- Only protects against specific chemicals
- Use requires monitoring of contaminant and oxygen levels
- Can only be used for gases or vapors with adequate warning properties, for specific gases or vapors where the service is known and a safety factor is applied, or units that have an end of useful life indicator

Example APRs



APR cartridges

- ◆ Operate only in negative pressure except for PAPR units
- ◆ Three types of filtering devices
 - Particulate filters
 - Cartridges and canisters that contain sorbents for specific gases or families of gases
 - Combination devices
- ◆ Cartridges usually attach to the facepiece
- ◆ Larger volume units attach to the chin of the facepiece or are carried with a harness and attached to the facepiece by a breathing tube
- ◆ Cartridges are color coded for the classes of chemicals they can be used with in accordance with 29 CFR 1910.134(g)

APR cartridges (Page 2)

- ❖ Most cartridges are stamped with an expiration date
- ❖ Once opened, humidity and other factors reduce their effectiveness and service life
- ❖ Cartridges should be discarded after use, but should not be used longer than one shift or when breakthrough occurs, whichever comes first

Breakthrough indicators

- 
- A silhouette of a sprinter in a starting crouch, positioned behind starting blocks on a track. The figure is dark and contrasts with the orange background.
- ◆ Chemical odor
 - ◆ Chemical taste
 - ◆ Irritation effects inside mask

Conditions excluding use of APRs

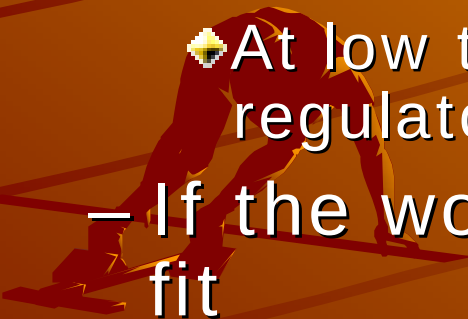
- ❖ Oxygen deficiency
- ❖ IDLH concentrations
- ❖ Entry into an unventilated or confined space where exposure has not been characterized
- ❖ Presence or potential presence of unidentified contaminants
- ❖ Contaminant concentrations are unknown or exceed designated maximum use concentrations
- ❖ Identified gases or vapors have inadequate warning properties and the absorbent service life is not known and the unit has no ESL indicator
- ❖ High relative humidity

Protection factor

- ◆ Level of protection is indicated by its protection factor
- ◆ Determined experimentally by measuring facepiece seal and exhalation valve leakage
- ◆ Indicates the relative difference in concentrations of substances outside and inside the facepiece that can be maintained by the respirator: a full face APR has a factor of 50, where one can use APR in concentrations up to 50 times the regulatory safe limits
- ◆ Source for PFs is ANSI

PF (Page 2)

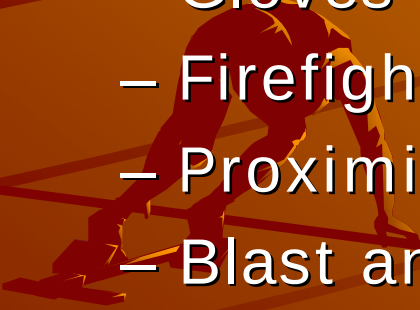
- ◆ Can be compromised by:
 - If a worker has a high breathing rate
 - ◆ Exhalation valves may leak
 - If the ambient temperature is high or low
 - ◆ High temperatures may cause sweating that breaks seal
 - ◆ At low temperatures, exhalation valve or regulator may not operate properly
 - If the worker has a poor facepiece to face fit
 - ◆ Facial hair
 - ◆ Missing teeth
 - ◆ Scars
 - ◆ Improper fit testing



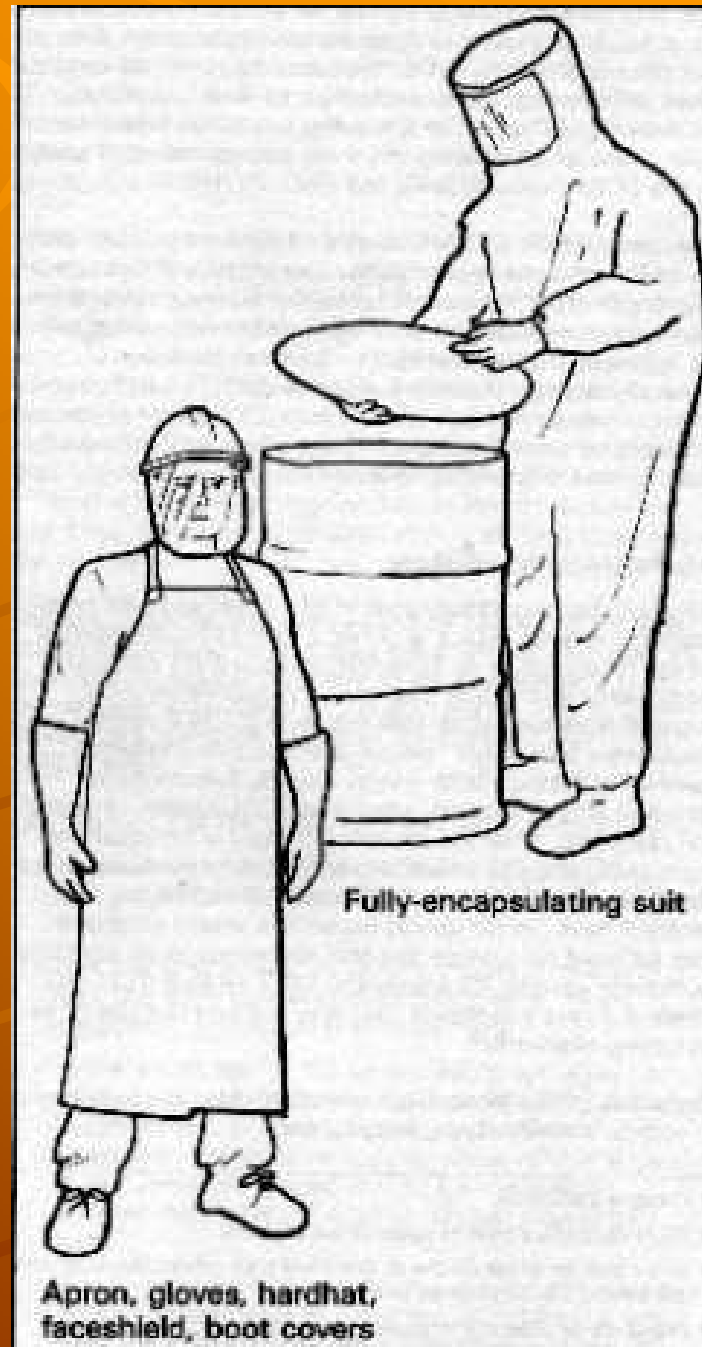
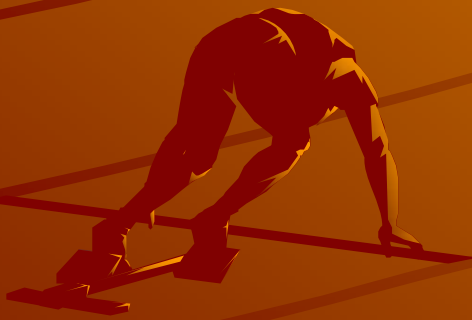
Selection of protective clothing

◆ Types

- Fully encapsulating suits
- Non-encapsulating suits
- Aprons, leggings and sleeve protectors
- Gloves
- Firefighters' protective clothing
- Proximity or approach garments
- Blast and fragmentation suits
- Cooling garments
- Radiation-protective suits



Example protective clothing



Fully-encapsulating suit

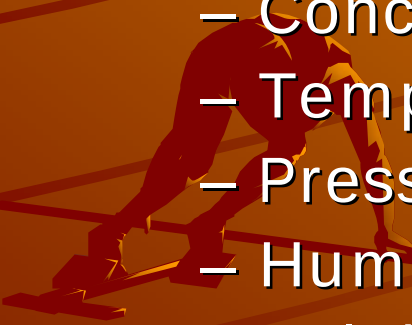
Apron, gloves, hardhat,
faceshield, boot covers

Permeation and degradation

- ◆ Selection depends upon the type and physical state of the contaminants
- ◆ Permeation is the process by which a chemical dissolves in and/or moves through the protective clothing on a molecular level
- ◆ Degradation is the loss of or change in the fabric's chemical resistance or physical properties due to exposure to chemicals, use or ambient conditions
- ◆ Penetration is the movement of chemicals through zippers, stitched seams or imperfections in the clothing

Permeation and degradation (Page 2)

- ❖ References exist that present permeation and degradation data
- ❖ Use vendor literature, if available
- ❖ Rate of permeation is a function of:
 - Clothing type and thickness
 - Manufacturing method
 - Concentration of chemical(s)
 - Temperature
 - Pressure
 - Humidity
 - Solubility of the chemical in the clothing material
 - Diffusion coefficient of the permeating chemical in the clothing



Clothing selection factors

◆ Durability

- Does the material have sufficient enough strength to withstand the physical stress of the tasks at hand?
- Will the material resist tears, punctures and abrasions?
- Will the material withstand repeated use after contamination/decon?

◆ Flexibility

- Will the clothing interfere with the workers' ability to perform their assigned tasks?

◆ Temperature effects

- Will the material maintain its protective integrity and flexibility under hot and cold extremes?

Clothing selection factors

(Page 2)

◆ Ease of decon

- Are decon procedures available on site?
- Will the material pose decon problems?
- Should disposable clothing be used?

◆ Compatibility with other equipment

- Does the clothing preclude the use of another necessary piece of protective equipment?

◆ Duration of use

- Can the required task be accomplished before contaminant breakthrough occurs or degradation of the clothing becomes significant

Full body protection

- Fully encapsulating suits
- Non-encapsulating suits
- Aprons, leggings and sleeve protectors
- Flame/fire retardant coveralls
- Firefighters' protective clothing
- Proximity or approach garments
- Blast and fragmentation suits
- Cooling garments
- Radiation-protective suits
- Floatation gear



Fully encapsulating suit

- ◆ One piece garment that may have boots and gloves as an integral part, or attached and replaceable or separate
- ◆ Protects against splashes, dusts, vapors and gases
- ◆ Does not allow body heat to escape; may contribute to heat stress
- ◆ A cooling garment may be needed
- ◆ Impairs worker mobility, vision and communication

Non-encapsulating suits

- ❖ Jacket, hood, pants or bib overalls and one-piece coveralls
- ❖ Protects against splashes, dust and other materials, but not against gases or vapors.
- ❖ Does not protect parts of head and neck
- ❖ Do not use where gas-tight or pervasive splashing protection is required
- ❖ May contribute to heat stress
- ❖ Tape-seal connections between pant cuffs and boot and gloves and sleeves

Aprons, leggings and sleeve protectors

- ◆ Fully sleeved and gloved apron, separate coverings for arms and legs, commonly worn over non-encapsulating suits
- ◆ Provides additional splash protection of chest, forearms and legs
- ◆ Whenever possible, should be used over a non-encapsulating suit to minimize potential for heat stress
- ◆ Useful for sampling, labeling and analysis operations, should be used only when there is a low probability of total body contact with contaminants

Firefighters' protective clothing

- ◆ Gloves, helmet, running or bunker coat, running or bunker pants, and boots
- ◆ Protects against heat, hot water and some particles. Does not protect against gases or vapors, chemical splashes or chemical permeation.
- ◆ Decon is difficult

Proximity Garment (approach suit)

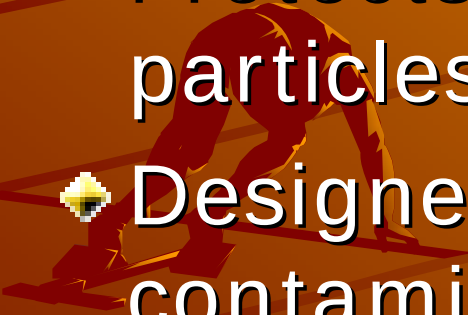
- ❖ One or two-piece overgarment with boot covers, gloves and hood of aluminized nylon or cotton; normally worn over other protective clothing, such as chemical-protective clothing, firefighters' garments, or flame-retardant coveralls
- ❖ Protects against brief exposure to radiant heat
- ❖ Can be custom manufactured to protect against some chemicals
- ❖ Does not protect against chemical permeation or degradation
- ❖ Auxiliary cooling and a SCBA should be used if exposure to toxic atmosphere or exposure could last more than 2-3 minutes

Blast & fragmentation suit

- ❖ Blast and fragmentation vests and clothing, bomb blankets and bomb carriers
- ❖ Provides protection against very small detonations. Bomb blankets and baskets can help redirect a blast
- ❖ Does not provide hearing protection or protection from chemicals

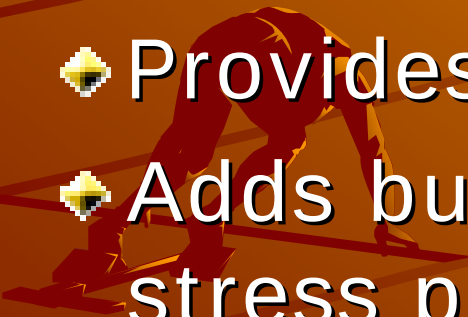
Radiation-contamination suit

- ❖ Various types of protective clothing designed to prevent contamination of the body by radioactive particles
- ❖ Protects against alpha and beta particles, but not gamma rays
- ❖ Designed to prevent skin contamination



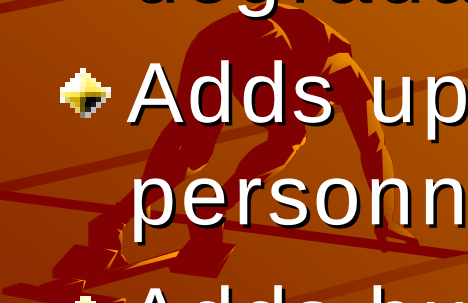
Flame/fire retardant overalls

- ◆ Normally worn as an undergarment
- ◆ Provides protection from flash fires
- ◆ Adds bulk and may exacerbate heat stress problems and impair mobility



Floatation gear

- ◆ Life jackets or work vests
- ◆ Can be worn under chemical protective clothing to prevent degradation by chemicals
- ◆ Adds up to 25 lbs of buoyancy to personnel working around water
- ◆ Adds bulk and restricts mobility
- ◆ Must meet USCG standards



Cooling garment

❖ Can be one of three methods

- A pump circulates cool dry air throughout the suit or portions of it via an airline; can enhance by adding a vortex cooler, refrigeration device or a heat exchanger
- A jacket or vest having pockets into which packets of ice are inserted
- A pump circulates chilled water from a water/ice reservoir and through tubes which cover a part of the body

Cooling garment (Page 2)

- ◆ Removes excess heat generated by worker activity, the equipment or the environment
- ◆ Pumps circulating cool air require excessive respirable air rates and are uneconomical for use at a waste site
- ◆ Jackets or vests pose ice storage and recharge problems
- ◆ Pumps circulating water pose ice storage problems and the pump and battery add bulk and weight

Head protection

- 
- ◆ Safety helmet
 - ◆ Helmet liner
 - ◆ Hood
 - ◆ Protective hair covering

Safety helmet (hard hat)

- ◆ A hard plastic or rubber helmet
- ◆ Protects the head from blows
- ◆ Helmets must meet OSHA standards at 29 CFR 1910.135



Helmet liner

- ◆ Placed inside the safety helmet
- ◆ Insulates against cold
- ◆ Does not protect against chemical splashes



Hood

- ◆ Commonly worn with a helmet
- ◆ Protects against chemical splashes, particulates, and rain



Protective hair covering

- ◆ Protects against chemical contamination of hair
- ◆ Prevents the entanglement of hair in machinery or equipment
- ◆ Prevents hair from interfering with vision and with the functioning of the respiratory protection devices
- ◆ Particularly important for workers with long hair

Eyes and face protection

- ◆ Face shield
- ◆ Splash hood
- ◆ Safety glasses
- ◆ Goggles
- ◆ Sweat bands

Face shield

- ◆ Full face coverage, 8 inch minimum
- ◆ Protects against chemical splashes
- ◆ Does not protect adequately against projectiles
- ◆ Face shields and splash hoods may be suitably supported to prevent them from shifting and exposing portions of face or obscuring vision
- ◆ Provides limited eye protection

Splash hoods safety glasses, and goggles

- ◆ Splash hoods protect against chemical splashes; do not protect against projectiles
- ◆ Safety glasses protect eyes from large particles and projectiles and one should use special lenses to protect against lasers
- ◆ Goggles can protect against vaporized chemicals, splashes, large particles and projectiles (if constructed with impact-resistant lenses)

Sweat bands

- ◆ Prevent sweat-induced eye irritation and vision impairment



Ear protection



◆ Ear plugs

◆ Ear muffs

◆ Headphones

Ear plugs and muffs

- ◆ Protect against physiological damage and psychological disturbance
- ◆ Must comply with OSHA 29 CFR 1910.95
- ◆ Can interfere with communication
- ◆ Use of ear plugs should be carefully viewed by a health and safety professional because chemical contaminants could be introduced into the ear

Headphones

- ❖ Radio headset with throat microphone
- ❖ Provides some hearing protection while enabling communications
- ❖ Highly desirable, particularly during an emergency



Hands and arms protection

- 
- ◆ Gloves and sleeves as a part of clothing
 - ◆ Overgloves
 - ◆ Disposable gloves

Gloves and sleeves

- ◆ May be integral, attached, or separate from other protective clothing
- ◆ Protects hands and arms from chemical contact
- ◆ Wear jacket cuffs over glove cuffs to prevent liquid from entering glove
- ◆ Tape-seal gloves to sleeves to provide additional protection
- ◆ Selection depends upon chemical contaminants

Overgloves and disposable gloves

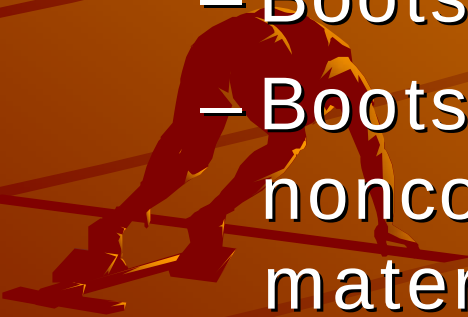
- ◆ Overgloves provide supplemental protection to the wearer and protect more expensive undergarments from abrasions, tears, and contamination
- ◆ Disposable gloves should be used whenever possible to reduce decon needs

Foot protection

◆ Safety boots

- Chemical resistant boots
- Boots constructed of other materials
- Boots constructed from nonconductive spark-resistant materials or coatings

◆ Disposable boots or boot covers



Safety boots

- ◆ Boots constructed of chemical resistant material protect feet from contact with chemicals
- ◆ Boots constructed with some steel materials protect feet from compression, crushing or puncture by falling, moving or sharp objects; all boots must meet OSHA 29 CFR 1910.136 and provide good traction
- ◆ Boots constructed of nonconductive materials protect the wearer against electrical hazards and prevent the ignition of combustible gasses or vapors

Disposable boots or boot covers

- ◆ Made of a variety of materials and slip over the shoe or boot
- ◆ Protect safety boots from contamination
- ◆ Protect feet from contact with chemicals
- ◆ Covers may be disposed of after use, facilitating decon

Other protection devices

- ◆ Knife
- ◆ Flashlight
- ◆ Personal dosimeter and chemical meter
- ◆ Personal locator beacon
- ◆ Two-way radio
- ◆ Safety belts, harnesses and lifelines

Knife

- ◆ Allows a person in a fully-encapsulating suit to cut his or her way out in the event of an emergency or equipment failure
- ◆ Should be carried and used with caution to avoid puncturing the suit

Flashlight or lantern

- ◆ Enhances visibility in buildings, enclosed spaces and the dark
- ◆ Must be intrinsically safe or explosion-proof for use in combustible atmospheres
- ◆ Sealing the light in a plastic bag facilitates decon

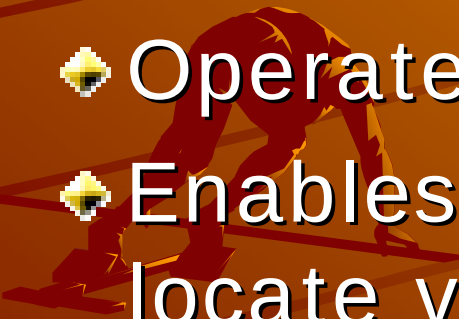
Personal dosimeter

- ❖ Measures worker exposure to ionizing radiation and to certain chemicals
- ❖ To estimate actual body exposure, the dosimeter should be placed inside the fully-encapsulating suit



Personal locator beacon

- ◆ Operated by sound, radio or light
- ◆ Enables emergency personnel to locate victim



Two-way radio

- ◆ Enables field workers to communicate with personnel in the SZ or other areas including other teams in the EZ
- ◆ Must meet explosion-proof standards if operating in an atmosphere with potential combustible gases or vapors

Safety belts, harnesses and lifelines

- ◆ Enable personnel to work in elevated areas or enter confined spaces and prevent falls. Belts may be used to carry tools and equipment
- ◆ Must be constructed of spark-free hardware and chemical-resistant materials and meet OSHA 29 CFR 1910.104



Selection of Ensembles

◆ EPA Levels of Protection

– A

– B

– C

– D

◆ Each ensemble must be tailored to the specific situation in order to provide the most appropriate level of protection

Selection of Ensembles

(Page 2)

- ◆ The type of equipment used and the overall level of protection should be reevaluated periodically and upgraded or downgraded as necessary

Reasons to upgrade

- ◆ Know or suspected presence of dermal hazards
- ◆ Occurrence or likely occurrence of gas or vapor emission
- ◆ Change in work task that will increase contact or potential contact with hazardous materials
- ◆ Request of the individual performing the task

Reasons to downgrade

- ◆ New information indicating that the situation is less hazardous than was originally thought
- ◆ Change in site conditions that decreases the hazards
- ◆ Change in work task that will reduce contact with hazardous materials

Level A

◆ Recommended units

- Pressure demand full facepiece SCBA
- Fully-encapsulating suit
- Inner chemical-resistant gloves
- Chemical-resistant safety boots/shoes
- Two-way radio

◆ Optional

- Cooling unit
- Coveralls
- Long cotton underwear
- Hard hat
- Disposable gloves and boot covers



Level A (Page 2)

- ◆ The highest available level of respiratory, skin and eye protection
- ◆ Should be used when the chemical substance has been identified and requires the protection, substances with a high degree of hazard to the skin are known or suspected to be present and skin contact is possible, or operations being conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A is determined
- ◆ Suit materials must be compatible with the substances involved

Level B

◆ Recommended items

- Pressure demand full facepiece SCBA
- Chemical resistant clothing
- Inner and outer chemical-resistant gloves
- Chemical resistant safety boots/shoes
- Hard hat
- Two-way radio

◆ Optional

- Coveralls
- Disposable boot covers
- Face shield
- Long cotton underwear

Level B (Page 2)

- ◆ Offers the same level of respiratory protection as Level A, but less skin protection
- ◆ It is the minimum level recommended for initial site entries until hazards have been further defined
- ◆ The type and atmospheric concentrations of substances have been identified and require respiratory protection including IDLH atmospheres and those that do not allow for APR use, and atmospheres with an oxygen content $<19.5\%$

Level B (Page 3)

- ◆ Presence of incompletely identified vapors or gases as indicated by DRI, but are not suspected of containing high levels of chemicals harmful to skin
- ◆ Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors or particulates or splashes of material that will affect exposed skin

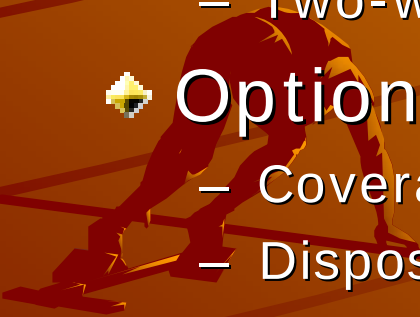
Level C

◆ Recommended items

- Full facepiece APR
- Chemical-resistant clothing
- Inner/outer chemical-resistant gloves
- Chemical resistant safety boots/shoes
- Hard hat
- Two-way radio

◆ Optional

- Coveralls
- Disposable boot covers
- Face shield
- Escape mask and escape SCBA
- Long cotton underwear



Level C (Page 2)

- ◆ The same level of skin protection as Level B, but a lower level of respiratory protection
- ◆ Used when the atmospheric contaminants, liquid splashes or other direct contact will not affect skin; the types of air contaminants have been identified, concentrations measured and a canister is available to remove them and all criteria for APRs are met
- ◆ Atmospheric levels must not exceed IDLH and there must be at least 19.5% oxygen in the atmosphere

Level D

◆ Recommended items

- Coveralls
- Safety boots/shoes
- Safety glasses or chemical splash goggles
- Hard hat

◆ Optional

- Gloves
- Escape mask or escape SCBA
- Face shield



Level D (Page 2)

- ◆ No respiratory and minimal skin protection
- ◆ The atmosphere should contain no known hazards
- ◆ Work functions should preclude splashes, immersions, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals
- ◆ This level should not be worn in the EZ
- ◆ The atmosphere must have oxygen >19.5%

Use of PPE

- ◆ Training
- ◆ Work mission duration
- ◆ Personal use factors
- ◆ Fit testing
- ◆ Donning
- ◆ Doffing
- ◆ In-use monitoring
- ◆ Inspection
- ◆ Storage
- ◆ Maintenance

Training

◆ Requirements found in 29 CFR 1910 Subparts I and Z

◆ The training

- Allows users to become familiar with equipment in a nonhazardous situation
- Instills confidence of the users in their equipment
- Makes the users aware of the limitations and capabilities of the equipment
- Increases efficiency of operations performed while wearing PPE
- May increase the protective efficiency of PPE
- Reduces the expense of PPE maintenance

Training (Page 2)

- ❖ Training should be completed before actual PPE use
- ❖ Training should delineate user's responsibilities
- ❖ Training should include both classroom and field training, when necessary



PPE training topics

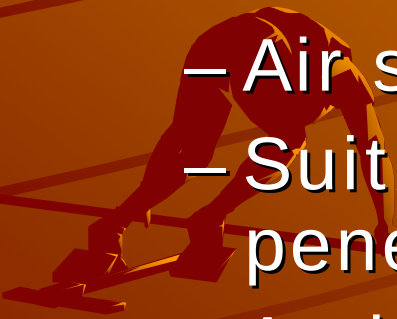
- ◆ OSHA requirements
- ◆ Proper use and maintenance of selected PPE, capabilities, limitations
- ◆ Nature of the hazards and consequences of not using PPE
- ◆ Human factors affecting PPE use
- ◆ Inspecting, donning, doffing, checking, fitting, and using PPE
- ◆ Individualized respirator fit testing

PPE training topics (Page 2)

- ◆ Use of PPE in normal air for a long familiarity period and finally in a test atmosphere to evaluate its effectiveness
- ◆ User's responsibilities for decon, cleaning, maintenance and repair of PPE
- ◆ Emergency procedures and self-rescue in the event of PPE failure
- ◆ The buddy system
- ◆ The SSP and the individual's responsibilities and duties in an emergency

Work mission duration

- ◆ Before the workers actually begin work in their PPE ensembles, the anticipated duration of the work should be established
- ◆ Factors include:
 - Air supply consumption
 - Suit/ensemble permeation and penetration by chemical contaminants
 - Ambient temperature
 - Coolant supply
 - Type of work



Air supply consumption

◆ In actual operation, several factors can reduce the rated SCBA operating times; these include:

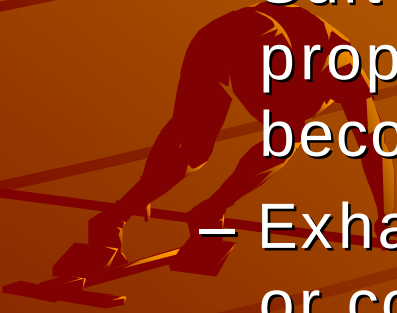
- Work rate: operating time may be reduced $\frac{1}{2}$ to $\frac{1}{3}$ during strenuous work
- Fitness: well-conditioned individuals generally utilize oxygen more efficiently and can extract more oxygen from a given volume of air
- Body size: larger individuals generally consume air at a higher rate
- Breathing patterns: quick, shallow or irregular breaths use air more rapidly than deep, regularly spaced breaths

Suit/ensemble permeation and penetration

◆ Causes:

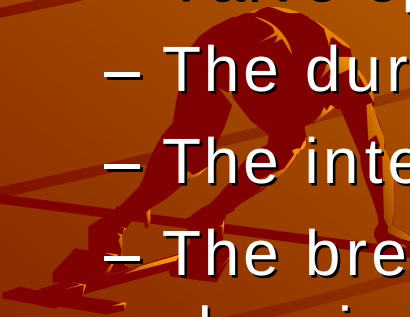
- Suit valve leakage, particularly under excessively hot or cold temperatures
- Suit fastener leakage if the suit is not properly maintained or if the fasteners become brittle at cold temperatures
- Exhalation valve leakage at excessively hot or cold temperatures

◆ No single clothing material is an effective barrier to all chemicals or all combinations of chemicals



Ambient temperature

- ◆ Has a major influence on work mission duration as it affects both the worker and the protective clothing
- ◆ Hot and cold ambient temperatures affect:
 - Valve operation on suits and respirators
 - The durability and flexibility of suit materials
 - The integrity of suit fasteners
 - The breakthrough time and permeation rates of chemicals
 - The concentration of airborne contaminants



Coolant supply

- ❖ Under warm or strenuous work conditions, adequate coolant should be provided to keep the wearer's body at a comfortable temperature and to reduce the potential for heat stress
- ❖ If coolant is necessary, the coolant supply will affect the mission duration

Personal use factors

- ◆ Facial hair and long hair
 - Interfere with respirator fit
- ◆ Eye glasses
 - Interfere with respirator fit if they have temple pieces; install a spectacle kit
- ◆ Gum and tobacco chewing should be prohibited during respirator use; they may compromise respirator fit and cause ingestion of chemical contaminants

Donning PPE

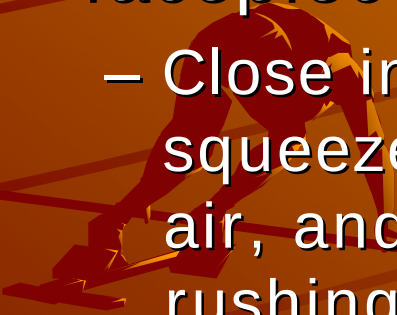
- ◆ Establish a routine and practice it periodically
- ◆ Provide assistance as necessary
- ◆ Evaluate the fit, once its been donned, make sure it is not too small or too large
 - A suit too small can tear the material, accelerate worker fatigue, restrict movement
 - A suit too large can result in snagging of unit, compromise the dexterity and coordination of worker
- ◆ Search for tears, rips, etc. and seal or change

Donning PPE sequence

- ❖ Inspect the clothing and respiratory equipment before donning
- ❖ Adjust hard hat or headpiece to fit user's head
- ❖ Open back closure used to change air tank before donning suit
- ❖ Standing or sitting, step into the legs of the suit; ensure proper placement of the feet within the suit; then gather the suit at the waist
- ❖ Put on the chemical-resistant safety boots over feet of the suit. Tape the leg cuff over the tops of the boot
 - If additional chemical-resistant boots are required, put these on now
 - Some one-piece suits have heavy-soled protective feet, with these, wear short, chemical-resistant safety boots inside suit

Donning PPE sequence (Page 2)

- ◆ Put on air tanks and harness assembly of SCBA; don the facepiece and adjust it to be secure, but comfortable; do not connect the breathing hose; open valve on air tank
- ◆ Perform negative and positive respirator facepiece seal test
 - Close inlet part with the palm of the hand or squeeze the breathing tube so it does not pass air, and gently inhale for 10 seconds, any inward rushing of air indicates a poor fit
 - Gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build up a positive pressure indicates a poor fit



Donning PPE sequence (Page 3)

- ◆ Depending on suit type
 - Put on long-sleeved inner gloves
 - Secure gloves to sleeves for suits with detachable gloves
 - Additional overgloves, worn over attached suit gloves may be donned later
- ◆ Put sleeves of suit over arms as assistant pulls suit up and over the SCBA; have assistant adjust suit to ensure unrestricted motion
- ◆ Put on hard hat, if needed
- ◆ Raise hood over head carefully so as not to disrupt face seal of SCBA mask; adjust hood to give satisfactory fit

Donning PPE sequence (Page 4)

- ✦ Begin to secure the suit by closing all fasteners on openings until there is only adequate room to connect the breathing hose; secure all belts and/or adjustable leg, head and waistbands
- ✦ Connect the breathing hose while opening the main valve
- ✦ Have assistant first ensure that wearer is breathing properly and then make final closure of the suit
- ✦ Have assistant check all closures
- ✦ Have assistant observe the wearer for a period of time to ensure that the wearer is comfortable, psychologically stable and that the equipment is functioning properly

Donning PPE Movie



In-use monitoring

- ◆ Report any perceived problems and difficulties to supervisor
- ◆ Malfunctions include:
 - Degradation of the protective materials
 - Perception of odors
 - Skin irritation
 - Unusual residues on PPE
 - Discomfort
 - Resistance to breathing
 - Fatigue due to respirator use
 - Interference with vision or communication
 - Restriction of movement
 - Personal responses such as rapid pulse, nausea and chest pain

Doffing PPE

- ◆ Establish procedures before using PPE
- ◆ Procedures must be established to prevent contamination migration from the work area and transfer of contaminants from the wearer's body to the doffing assistant and others



Doffing sequence with plenty of air

- ◆ Remove any extraneous or disposable clothing, boot covers, outer gloves and tape
- ◆ Have assistant loosen and remove the wearer's safety shoes or boots; keep SCBA active
- ◆ Have assistant open the suit completely and lift the hood over the head of the wearer and rest it on top of the SCBA tank
- ◆ Remove arms, one at a time, from the suit; have assistant lift the suit up and away from the SCBA backpack and lay the suit flat behind wearer
- ◆ Sitting, if possible, remove both legs from the suit
- ◆ Follow procedure for doffing SCBA
- ◆ Remove internal gloves by rolling them off the hands, inside out
- ◆ Remove internal clothing and cleanse body

Doffing sequence after low air warning signal

- ◆ Remove disposable clothing
- ◆ Quickly scrub and hose off suit, especially around openings
- ◆ Open the zipper enough to allow access to the regulator and breathing hose
- ◆ Immediately attach an appropriate canister to the breathing hose
- ◆ Follow the steps for doffing with plenty of air

Doffing PPE Movie



Clothing reuse

- ❖ Chemicals that have permeated suit may not be removed during decon and may continue to diffuse through the material towards the inside surface
- ❖ Clothing should be checked inside and out for discoloration or other evidence of contamination
- ❖ The reuse of chemical protective clothing that has been contaminated is not advised

PPE inspection

◆ An effective PPE program will have five different inspection:

- Inspection and operational testing of equipment received from the factory
- Inspection of equipment as it is issued to workers
- Inspection after use or training and prior to maintenance
- Periodic inspection of stored equipment
- Periodic inspection when a question arises concerning the effectiveness of the selected equipment or when problems with similar equipment arise

PPE inspection (Page 2)

- ◆ Each inspection will cover somewhat different areas in varying degrees of depth
- ◆ Records must be kept of all inspection procedures
- ◆ Individual ID numbers should be assigned to all reusable pieces of equipment and records should be maintained by that number
- ◆ Each inspection should record:
 - ID No.
 - Date
 - Inspector
 - Unusual conditions or findings

Clothing PPE Inspection checklist

◆ Before use:

- Determine that the clothing material is correct for the specified task at hand
- Visually inspect for:
 - ◆ Imperfect seams
 - ◆ Non-uniform coatings
 - ◆ Tears
 - ◆ Malfunctioning closures
- Hold up to light and check for pinholes
- Flex product
 - ◆ Observe for cracks



Clothing PPE Inspection checklist

(Page 2)

- If the product has been used previously, inspect inside and out for signs of chemical attack:

- ◆ Discoloration
- ◆ Swelling
- ◆ Stiffness
- ◆ Softening

- ◆ During the work task, periodically inspect for:

- Evidence of chemical attack
- Closure failure
- Tears
- Punctures



Glove Inspection checklist

◆ Before use

- Pressurize gloves to check for pinholes

- ◆ Blow into glove then roll glove towards fingers

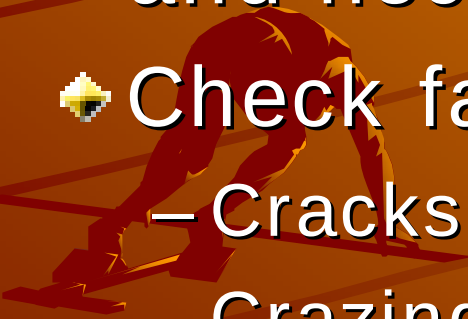
- ◆ Inflate glove and hold under water

- ◆ No air should escape



Fully-encapsulating suits inspection checklist

- ◆ Check the operation of pressure relief valves
- ◆ Inspect the fitting of wrists, ankles and neck
- ◆ Check faceshield for:
 - Cracks
 - Crazing
 - Fogginess



SCBA inspection checklist

♦ Inspect SCBA:

- Before and after each use
- At least monthly when in storage
- Every time they are cleaned

♦ Check all connections for tightness

♦ Check material conditions for:

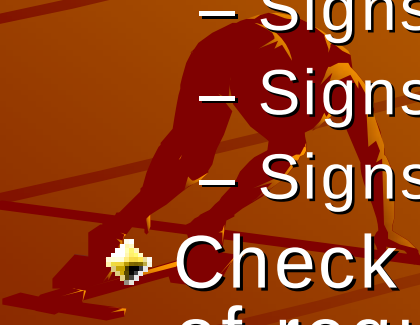
- Signs of pliability
- Signs of deterioration
- Signs of distortion

♦ Check for proper setting and operation of regulators and valves

♦ Check operation of alarms

♦ Check faceshields for:

- Cracks, crazing, fogginess



SAR inspection checklist

- ◆ Inspect SARs:
 - Daily when in use
 - At least monthly when in storage
 - Every time they are cleaned
- ◆ Inspect air lines prior to each use for cracks, kinks, cuts, frays, and weak areas
- ◆ Check for proper setting and operation of regulators and valves
- ◆ Check all connections for tightness
- ◆ Check material conditions for:
 - Signs of pliability, deterioration, distortion
- ◆ Check faceshields for:
 - Cracks, crazing, fogginess

APR inspection checklist

◆ Inspect APR

- Before (to be sure they have been adequately cleaned) and after each use
- At least monthly when in storage
- Every time they are cleaned

◆ Check material conditions for:

- Signs of pliability
- Signs of deterioration
- Signs of distortion

◆ Examine cartridges or canisters to ensure that:

- They are the proper type for the intended use
- The expiration date has not been passed
- They have not been opened or used previously

◆ Check faceshields for:

- Cracks crazing fogginess

PPE storage

- ◆ Clothing and respirators must be stored properly to prevent damage or malfunction due to :
 - Dust
 - Moisture
 - Sunlight
 - Damaging chemicals
 - Extreme temperatures
 - Impact
- ◆ Procedures must be specified for both pre-issuance warehousing and post-issuance (in use) storage
- ◆ Many equipment failures can be attributed to improper storage



Clothing storage

- ◆ Potentially contaminated clothing should be stored in an area separate from street clothing
- ◆ Should be stored in a well-ventilated area, with good air flow around each item
- ◆ Store different types and materials of clothing separately to prevent issuing of the wrong type
- ◆ Be folded or hung according to the manufacturer's recommendations

Respirator storage

- ◆ SCBAs, SARs and APRs should be dismantled, washed and disinfected after use
- ◆ SCBAs should be placed in storage chests supplied by the manufacturer
- ◆ APRs should be stored individually in their original cartons or carrying cases, or in heat-sealed or resealable plastic bags

PPE maintenance

- ◆ Explicit procedures should be adopted to ensure that the appropriate level of maintenance is performed only by individuals having the specialized training
- ◆ Level 1
 - User or wearer maintenance
- ◆ Level 2
 - Shop maintenance that can be performed at employer's shop
- ◆ Level 3
 - Specialized maintenance that can be performed only by the factory or an authorized representative

Heat stress and other physiological factors

- ◆ Wearing PPE puts a serious strain on the worker
- ◆ A result of this stress can be heat stress
- ◆ Heat stress is one of the most common illnesses at a hazardous waste site
- ◆ Factors include:
 - Environmental conditions
 - Clothing
 - Work load
 - Individual characteristics



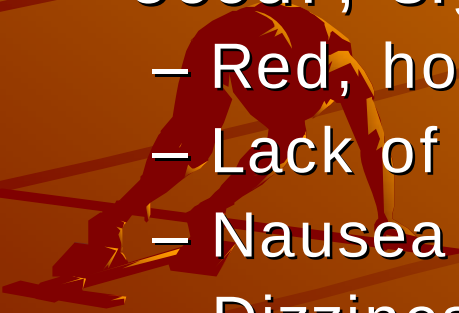
Signs of heat stress

- ◆ Heat rash
- ◆ Heat cramps caused by heavy sweating with inadequate electrolyte replacement; symptoms include:
 - Muscle spasms
 - Pain in the hands, feet and abdomen
- ◆ Heat exhaustion occurs from increased stress on various body organs, including inadequate blood circulation due to cardiovascular insufficiency or dehydration; signs
 - Pale, cool, moist skin
 - Heavy sweating
 - Dizziness
 - Nausea
 - Fainting

Signs of heat stroke

◆ Heat stroke is when the body's temperature regulation fails and the body temperature rises to critical levels; immediate action must be taken to cool the body before serious injury and death occur; signs:

- Red, hot, usually dry skin
- Lack of or reduced perspiration
- Nausea
- Dizziness and confusion
- Strong, rapid pulse
- Coma



Individual characteristics affecting heat stress

- ◆ Lack of physical fitness
- ◆ Lack of acclimatization
- ◆ Age
- ◆ Dehydration
- ◆ Obesity
- ◆ Alcohol and drug use
- ◆ Infection
- ◆ Sunburn
- ◆ Diarrhea
- ◆ Chronic disease

PPE effects on heat stress

- ◆ Reduced work tolerance
- ◆ Type of PPE worn
- ◆ Adds bulk and weight
- ◆ Severely reduces the body's access to normal heat exchange mechanisms
 - Evaporation
 - Convection
 - Radiation
- ◆ Increases energy expenditure



Rest periods

◆ Number and duration determined by:

- Anticipated work rate
- Ambient temperature and other environmental factors
- Type of protective materials used
- Individual worker characteristics and fitness



Heat stress monitoring

- ◆ Monitor workers when temperature exceeds 70°F (21°C)
- ◆ To monitor workers check during rest periods for:
 - Heart rate
 - ◆ If the rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by 1/3
 - Oral temperature
 - ◆ If oral temperature exceeds 99.6°F (37.6°C), shorten the work cycle by 1/3 without changing the rest period
 - ◆ Do not permit a worker wearing semipermeable or impermeable garments to work when his/her temperature exceeds 100.6°F (38.1°C)

Heat stress monitoring (Page 2)

– Body water loss

- ◆ Measure weight on an accurate scale to within 0.25 lb at the beginning and end of each work day to see if enough fluids have been taken to prevent dehydration

- ◆ The body water loss should not exceed 1.5% total body weight loss in a work day

- ◆ The frequency of monitoring depends upon the air temperature adjusted for solar radiation and the level of physical work



Recommended monitoring

◆ 90°F (32.2°C) and above

- Normal work ensemble

 - ◆ After each 45 minutes of work

- Impermeable ensemble

 - ◆ After each 15 minutes of work

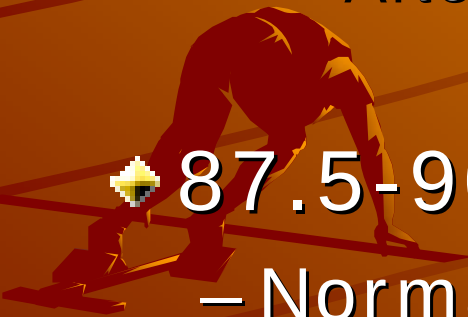
◆ 87.5-90°F (30.8-32.2°C)

- Normal work ensemble

 - ◆ After each 60 minutes of work

- Impermeable ensemble

 - ◆ After each 30 minutes of work



Recommended monitoring (Page 2)

◆ 82.5-87.5°F (28.1-30.8°C)

- Normal work ensemble

 - ◆ After each 90 minutes of work

- Impermeable ensemble

 - ◆ After each 60 minutes of work

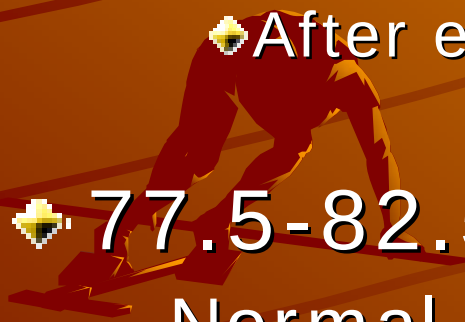
◆ 77.5-82.5°F (25.3-28.1°C)

- Normal work ensemble

 - ◆ After each 120 minutes of work

- Impermeable ensemble

 - ◆ After each 90 minutes of work



Recommended monitoring (Page 3)

◆ 72.5-77.5°F (22.5-25.3°C)

– Normal work ensemble

◆ After each 150 minutes of work

– Impermeable ensemble

◆ After each 120 minutes of work

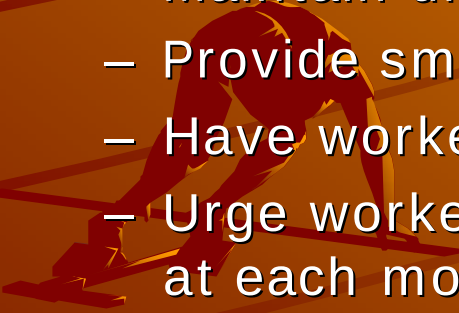


Heat stress prevention

- ◆ Adjust work schedules
 - Modify work/rest schedules according to monitoring results
 - Mandate work slowdowns, as needed
 - Rotate personnel: alternate job functions to minimize overstress or overexertion at one task
 - Add additional personnel to work teams
 - Perform work during cooler hours of the day
- ◆ Provide air conditioned shelter or shaded areas to protect personnel during rest periods
- ◆ Train workers to recognize and treat heat stress, including signs and symptoms

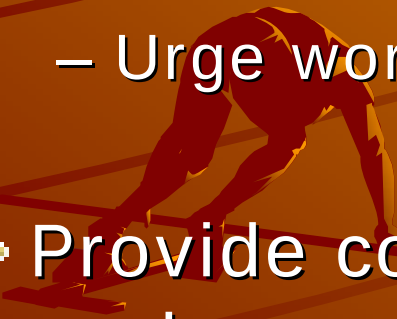
Heat stress prevention (Page 2)

- ◆ Maintain workers' body fluids at normal levels.
- ◆ Daily fluid intake should equal the amount lost in sweat, 8 ozs. of water should be taken for every 8 ozs. of sweat
 - Maintain drinking water temperature at 50-60°F (10-15.6°C)
 - Provide small disposable cups that hold about 4 ozs.
 - Have workers drink 10 ozs. of fluid before beginning work
 - Urge workers to drink a cup or two every 15-20 minutes or at each monitoring break
 - Weigh workers before and after work to determine if fluid replacement is adequate



Heat stress prevention (Page 3)

- ◆ Encourage workers to maintain an optimal level of physical fitness
 - Where indicated, acclimatize workers to site work conditions: temperature, protective clothing and workload
 - Urge workers to maintain normal weight levels
- ◆ Provide cooling devices to aid natural body heat exchange during prolonged work or severe heat exposure
 - Field showers or hose-down areas
 - Cooling jackets, vests or suits



Physiological factors and PPE

- ◆ Physical condition
- ◆ Level of acclimatization
- ◆ Age
- ◆ Gender
- ◆ Weight

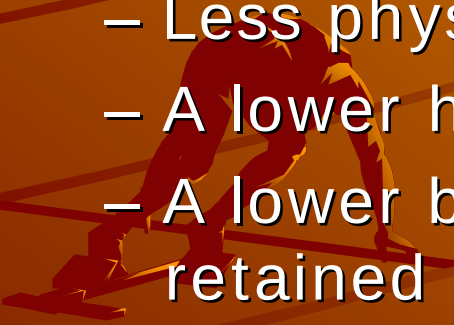


Physical condition

◆ The more physically fit a person is, the more work they can perform safely

◆ A fit person will have:

- Less physiological strain
- A lower heart rate
- A lower body temperature, which indicates less retained body heat
- A more efficient sweating mechanism
- Slightly lower oxygen consumption
- Slightly lower carbon dioxide production



Level of acclimatization

- ◆ The degree to which a person's body has acclimatized to working under hot conditions affects his or her ability to work
- ◆ Acclimatized individuals have generally lower heart rates and sweat sooner and more profusely
- ◆ They maintain a lower skin and body temperature at a given level of environmental heat and work loads than unacclimatized
- ◆ Sweat decomposition also becomes more dilute with acclimatization, which reduces salt loss



Level of acclimatization

(Page 2)

- ◆ NIOSH recommends a progressive 6-day acclimatization period for the unacclimatized worker before allowing him/her to perform a full work load
 - The first day will be at 50% of normal work load and will be increased by 10% each day
- ◆ A fit person will become acclimatized within 2-3 days
- ◆ Workers can lose acclimatization in a matter of days and work regimens should be adjusted to account for this

Level of acclimatization (Page 3)

◆ Fit acclimatized individuals in an impermeable suit sweat more profusely and may actually face a greater danger of heat exhaustion due to rapid dehydration

◆ This can be prevented by consuming large quantities of water



Age

- ❖ Maximum work capacity declines with increasing age
- ❖ Active, well-conditioned seniors though often have performance capabilities equal to or greater than young sedentary individuals
- ❖ Older individuals are less effective in compensating for a given level of environmental heat and work loads
- ❖ At moderate thermal loads, the physiological responses of young and old are similar and performances are not affected

Gender

- ◆ Females tolerate heat stress at least as well as males
- ◆ Generally, a female's work capacity averages 10-30% less than a male
- ◆ The primary reasons are the greater oxygen-carrying capacity and the stronger heart in the male
- ◆ Not all males have greater work capacities than all females

Weight

- ❖ The ability of the body to dissipate heat depends upon the ratio of its surface area to its mass
- ❖ Heat loss is a function of surface area and heat production dependent on mass
- ❖ Overweight individuals produce more heat per unit of surface area
- ❖ Overweight individuals should be given special consideration in heat stress situations
- ❖ However, when wearing impermeable equipment, the weight of an individual is not a critical factor in determining the ability to dissipate excess heat



Lesson 8

AIR MONITORING



Air monitoring

- ◆ Airborne contaminants can present a significant threat to workers on site
- ◆ Useful for:
 - Selecting PPE
 - Delineating areas where protection is needed
 - Assessing the potential health effects of exposure
 - Determining the need for specific medical monitoring

Measuring instruments

- ◆ Direct reading instruments
- ◆ Laboratory analysis of air samples



Direct reading instruments (DRI)

- ◆ Early warning for use in industrial settings
- ◆ Can detect down to parts per million range
- ◆ Can rapidly detect flammable or explosive atmospheres, oxygen deficiency, certain gases and vapors, and ionizing radiation
- ◆ Used to institute protective measures for site workers
- ◆ Used to determine the appropriate equipment for further monitoring
- ◆ Used to develop optimum sampling and analytical protocols

Constraints on DRI

- ❖ Usually detect and/or measure only specific classes of chemicals
- ❖ Not generally designed to measure and/or detect airborne concentrations below 1 ppm
- ❖ Many, designed for a specific chemical, also detect other substances that interfere and may give false readings

Guidelines to ensure effective DRI results

- ❖ Calibrate instruments according to manufacturer's instructions before use
- ❖ Develop chemical response curves
- ❖ Remember the instrument's readings have limited value where there are unknown chemicals
- ❖ A reading of "zero" should be reported as "no instrument response" rather than "no chemical present"
- ❖ The survey should be repeated with several different detection systems

Types of DRI

- ◆ Combustible gas meter
- ◆ Flame ionization detector
- ◆ Gamma radiation survey instrument
- ◆ Portable infrared spectrophotometer
- ◆ Ultraviolet Photoionization detector
- ◆ Direct reading colorimetric reading tubes
- ◆ Oxygen meter

Combustible gas meter

- ❖ Measures the concentration of combustible gases and vapors
- ❖ Accuracy depends upon difference between calibration and sampling temperatures
- ❖ Sensitivity is dependent upon the differences in physical and chemical properties between the calibration gas and the gas being measured
- ❖ Silicones, halides, tetraethyl lead and oxygen enriched atmospheres can damage instrument
- ❖ Does not provide a valid reading in oxygen-deficient conditions
- ❖ Operator should understand the operating principles and procedure
- ❖ Must recharge or replace battery and calibrate before use

Flame ionization detector (FID)

- ◆ Measures organic gases and vapors that are ionized in a flame; a current is produced in proportion to the number of carbon atoms
- ◆ Does not detect inorganic vapors or some synthetics
- ◆ Sensitivity depends upon the compound
- ◆ Should not be used below 40°F
- ◆ Difficult to absolutely identify compounds
- ◆ High concentrations of contaminants or oxygen deficient atmospheres require system modifications
- ◆ Requires experience in interpreting data correctly

FID (Page 2)

- ❖ Specific identification requires calibration with the specific analyte of interest
- ❖ Can be used with a gas chromatograph for more accurate results
- ❖ Must recharge or replace battery and monitor flame gas
- ❖ Check instrument for leaks and perform routine maintenance
- ❖ Typically can operate on a charge for up to 8 hours
- ❖ In survey mode, all organic compounds are ionized and detected at the same time

Gamma radiation survey instrument

- ◆ Environmental radiation monitor
- ◆ Does not detect alpha or beta radiation
- ◆ Easy to use but requires experience to interpret data
- ◆ Must be calibrated annually
- ◆ Rugged, good in field use
- ◆ Can be used as long as battery lasts

Portable Infrared (IR)

- ◆ Detects many gases and vapors
- ◆ Measure the concentration of gases and vapors in air
- ◆ Designed to quantify one or two component mixtures
- ◆ Passes different frequencies of IR through the sample with different frequencies being absorbed by different compounds
- ◆ Requires 115-volt AC power

IR (Page 2)

- ◆ Must make repeated passes to achieve reliable results
- ◆ Not approved for use in potentially explosive or flammable atmospheres
- ◆ Interference by water vapor and carbon dioxide
- ◆ Certain vapors and high moisture may attack the instrument's optics
- ◆ Requires personnel with extensive IR experience

Ultraviolet photoionization detector (PID)

- ❖ Measure concentrations of organic and some inorganic gases and vapors
- ❖ Some identification of compounds is possible
- ❖ Ionizes molecules using UV radiation and produces a current in proportion to the number of ions
- ❖ Does not detect methane
- ❖ Does not detect a compound if the probe used has a lower energy level than the compound's ionization potential
- ❖ Response may change when gases are mixed

PID (Page 2)

- ◆ Other voltage sources may interfere with measurements
- ◆ Readings can only be reported in relation to calibration gas
- ◆ Response is affected by high humidity
- ◆ Requires that the operator understand the operating principles and procedures, and be competent in calibrating, reading and interpreting data
- ◆ Must recharge or replace battery, regularly clean lamp window and clean and maintain instrument
- ◆ Last up to 10 hours on a single charge

Colorimetric tubes

- ❖ Measures the concentrations of specific gases or vapors
- ❖ Compound reacts with the indicator tube chemical producing a stain whose length and color change in proportion to concentration
- ❖ Many similar chemicals can interfere
- ❖ Greatest error comes from judging color and the tube's limited accuracy
- ❖ Minimal operator training required
- ❖ Do not use previously used tube
- ❖ Check pump for leaks before and after use
- ❖ Refrigerate prior to use; shelf life about 2 yrs.
- ❖ Check expiration date of tube
- ❖ Calibrate pump volume quarterly

Oxygen meter

- ◆ Measure the percentage of oxygen in air
- ◆ Uses an electrochemical sensor to measure the partial pressure of oxygen
- ◆ Must be calibrated prior to use
- ◆ Certain gases can affect readings
- ◆ Effective use requires that the operator understand the operating principles and procedures
- ◆ Replace detector cell according to manufacturer
- ◆ Recharge or replace battery
- ◆ If the atmosphere is more than 0.5% carbon dioxide, replace or rejuvenate the oxygen detector cell frequently
- ◆ Operates 8-12 hours

Sample collection devices

◆ Anions

- Pre-washed silica gel tube

◆ Aliphatic aromatics

- Silica gel

◆ Asbestos

- Mixed cellulose ester filter

◆ Metals

- Mixed cellulose ester filter

◆ Organics

- Charcoal tube



Collection devices (Page 2)

◆ Nitrosamines

- Thermosorb/N

◆ Particulates

- Mixed cellulose ester filter

◆ PCBs

- Glass fiber filter and florisil tube

◆ Pesticides

- 13 mm GF filter and chromosorb 102
Tube

Analytical methods and detection limits

◆ Anions:

– Ion chromatography



◆ Bromide:	10 micrograms
◆ Chloride:	5 micrograms
◆ Fluoride:	5 micrograms
◆ Nitrate:	10 micrograms
◆ Phosphate:	20 micrograms
◆ Sulfate:	10 micrograms

◆ Aliphatic Amines

- Gas chromatograph (GC),
nitrogen/phosphorous detector
- ◆ 10 micrograms

Analytical methods (Page 2)

◆ Asbestos

- Phase contrast microscopy

- ◆ 100 fibers/mm

◆ Metals

- Inductively coupled plasma (ICP),
atomic emission spectrometry

- ◆ 0.5 micrograms

◆ Organics

- GC/mass spectrometry

- ◆ 10 micrograms

Analytical methods (Page 3)

◆ Nitrosamines

- GC/thermal energy analyzer

- ◆ 0.01 micrograms

◆ Particulates

- Gravimetric

◆ PCBs

- GC-electrical conductivity detector

- ◆ 0.001 micrograms

◆ Pesticides

- GC/MS

- ◆ 0.05 micrograms

Site monitoring

- 
- ◆ Monitoring for IDLH
 - ◆ General onsite monitoring
 - ◆ Perimeter monitoring
 - ◆ Periodic monitoring

IDLH monitoring

- ◆ Monitor for IDLH
- ◆ Monitor for flammable and explosive gas atmospheres
- ◆ Monitor for oxygen-deficient atmospheres
- ◆ Monitor for highly toxic atmospheres
- ◆ Look for confined or low-lying areas where vapors may concentrate
- ◆ Examine confined spaces
- ◆ Contaminants are lighter or heavier than air

Possible confined spaces

- ◆ Tanks
- ◆ Buildings
- ◆ Cargo holds
- ◆ Mine shafts
- ◆ Silos
- ◆ Box cars
- ◆ Bulk tanks
- ◆ Sumps
- ◆ Trenches
- ◆ Hollows

General site monitoring

- ◆ Visually identify the sources of possible generation
- ◆ Collect air samples down wind from the source along the axis of the wind direction
- ◆ Work upwind until reaching the source
- ◆ Sample cross axis to determine the degree of dispersion
- ◆ Smoke plumes may be released as an aid

Perimeter monitoring

- ◆ Measures the migration of contaminant away from site
- ◆ Enables the SSHO to evaluate the integrity of the site's clean areas
- ◆ Wind speed and direction data are needed to interpret the sample results



Periodic Monitoring

- ◆ Site conditions change, periodically sample when:
 - Work begins on a different portion of the site
 - Different contaminants are being handled
 - A markedly different type of operation is begun
 - Workers are handling leaking drums or working in areas with obvious liquid contamination

Personal monitoring

- ◆ Measure contaminants for workers closest to the source
- ◆ Collect samples in the breathing zone
- ◆ Use pumps to collect samples that automatically maintain a constant flow rate
- ◆ Protect pumps with disposable coverings to make decon easier
- ◆ Several days may be required to cover all possible contaminants
- ◆ If workers are in teams, monitor each worker for a different contaminant

Factors affecting site exposure

- ◆ Increases in temperature increase the vapor pressure of most chemicals
- ◆ Increased wind speed can affect vapor concentration
- ◆ Rainfall can cap or plug vapor emissions
- ◆ Dusts can be reduced by moisture
- ◆ Displacement of vapors can increase concentrations in the short term
- ◆ Work activities often increase emissions

Lesson 9

MEDICAL PROGRAM



Medical program

- ◆ Developing a program
- ◆ Pre-employment screening
- ◆ Periodic medical examination
- ◆ Termination examination
- ◆ Emergency treatment
- ◆ Non-emergency treatment
- ◆ Medical records
- ◆ Program review

Purpose

- ◆ Assess and monitor workers' health and fitness both prior to and during the course of work
- ◆ Provide emergency and other treatment as needed
- ◆ To keep adequate records for future use
- ◆ To meet OSHA program requirements
 - Respirator (29 CFR 1910.134)
 - 29 CFR 1910.95
 - 29 CFR 1910.1001-.1045

Purpose (Page 2)

- ◆ Conduct future epidemiological studies
- ◆ Adjudicate claims
- ◆ Provide evidence in litigation
- ◆ Report workers' medical conditions to local, state and federal agencies



Developing a program

- ◆ Developed for each site based on the specific needs, location and potential exposure of employees
- ◆ Designed by an experienced occupational health physician or other qualified occupational health consultant
- ◆ Director of program should be a physician board certified in occupational medicine

Developing a program (Page 2)

- ◆ May be managed by a local physician or a qualified RN under the direction of a qualified physician
- ◆ All medical tests should be performed by a laboratory that has demonstrated satisfactory performance in an inter-laboratory testing program

Components of medical programs

- ◆ Medical surveillance
 - Pre-employment physical
 - Periodic medical examinations
 - Termination examination
- ◆ Treatment
 - Emergency
 - Non-emergency
- ◆ Recordkeeping
- ◆ Program review

Management duties

- ◆ Urge prospective employees to provide a complete and detailed occupational and medical history
- ◆ Assure employees of confidentiality
- ◆ Require workers to report any suspected exposures
- ◆ Require workers to bring unusual physical or psychological conditions to physician's attention.
- ◆ Emphasize that vague disturbances or apparently minor complaints may be important

Program development

- ◆ Consider site conditions for monitoring
- ◆ Consider the needs of individual worker, based on medical and occupational history
- ◆ Consider current and potential exposures on the site



Potential exposures

- ◆ Aromatic hydrocarbons
- ◆ Asbestos
- ◆ Dioxin
- ◆ Halogenated aliphatic hydrocarbons
- ◆ Heavy metals
- ◆ Herbicides
- ◆ Organochlorine pesticides
- ◆ Organophosphate and carbamate insecticides
- ◆ Polychlorinated biphenyls

Aromatic Hydrocarbons

- ◆ Typical compounds: benzene, ethylbenzene, toluene and xylene
- ◆ Uses: Commercial solvents and intermediates in chemical and pharmaceutical compounds
- ◆ Target organs: blood, bone marrow, central nervous system (CNS), eyes, respiratory system, skin, liver and kidney

Aliphatic Hydrocarbons

(Page 2)

- ◆ Health effects: CNS depression, decreased alertness, headache, sleepiness, loss of consciousness, defatting dermatitis, leukemia, cancer
- ◆ Monitoring: Medical and occupational history, physical exam with focus on liver, kidney, skin and nervous system, complete blood count (CBC) tests, platelet counts, kidney and liver function tests



Asbestos

- ◆ Uses: industrial insulation
- ◆ Target organs: lungs, gastrointestinal system
- ◆ Health effects: lung cancer, mesothelioma, asbestosis, gastrointestinal malignancies
- ◆ Test: Physical exam with focus on lungs, stool test for occult blood, high quality chest x-ray, pulmonary function test



Halogenated Aliphatic Hydrocarbons

- ❖ Chemicals: carbon tetrachloride, chloroform, ethyl bromide, ethyl chloride, ethylene dibromide, ethylene dichloride, methyl chloride, methyl chloroform, methylene chloride, tetrachloroethane, tetrachloroethylene, trichloroethylene, vinyl chloride
- ❖ Uses: commercial solvents and intermediates
- ❖ Target organs: CNS, kidney, liver, skin
- ❖ Health effects: CNS depression, decreased alertness, headache, sleepiness, loss of consciousness, decreased urine flow, swelling anemia, fatigue, malaise, dark urine, liver enlargement, jaundice, cancer



Halogenated Aliphatic Hydrocarbons (Page 2)

- ◆ Tests: occupational/medical history, physical exam with focus on liver and kidney function including lab testing, nervous system, skin, carboxyhemoglobin

Heavy metals

- ◆ Chemicals: arsenic, beryllium, cadmium, chromium, lead, mercury
- ◆ Uses: wide variety of industrial and commercial uses
- ◆ Target organs: blood, cardiopulmonary, gastrointestinal, kidney, liver, lung, CNS, skin



Heavy metals (Page 2)

- ◆ Health effects: toxicity to kidney, decreased mental ability, weakness, headache, cramps, anemia, brain damage, cancer
- ◆ Monitoring: Search for history cluster of symptoms, including anemia, gastrointestinal symptoms, lab measurements of metal concentrations, CBC, measurement of liver and kidney function, chest x-ray, pulmonary function testing

Herbicides and Dioxin

- ◆ Compounds: 2,4-D, dioxin, 2,4,5-T
- ◆ Uses: vegetation control
- ◆ Target organs: kidney, liver, CNS, skin
- ◆ Health effects: chloracne, weakness or numbness of extremities, nerve damage, liver and kidney disease
- ◆ Monitoring: history, physical exam focused on skin and nervous system, urinalysis, measuring liver and kidney function

Organochlorine insecticides

- ◆ Compounds: DDT, aldrin, chlordane, dieldrin, endrin, lindane
- ◆ Uses: Pest control
- ◆ Target organs: kidney, liver, CNS
- ◆ Health effects: irritability, dizziness, disturbed equilibrium, tremor, convulsions, anemia, liver toxicity, kidney damage
- ◆ Monitoring: History, physical exam focused on nervous system, measuring liver and kidney function, CBC

Organophosphate insecticides

- ◆ Compounds: diazinon, dichlorvos, dimethoate, trochlorfon, malathion, methyl parathion, aldicarb, baygon, zectran
- ◆ Uses: Pest control
- ◆ Target organs: CNS, liver, kidney
- ◆ Health effects: neuromuscular blockage, headaches, dizziness, fatigue, increased salivation, profuse sweating, nausea, vomiting, cramps, diarrhea, tightness in chest, muscle twitching, slowing of heartbeat, unconsciousness, seizures, weakness and numbness in hands and feet



Organophosphate insecticides

(Page 2)

- ◆ Monitoring: physical exam focused on nervous system, red blood count (RBC) cholinesterase, measurement of delayed neurotoxicity

Polychlorinated biphenyl (PCB)

- ◆ Uses: insulation and fire retardant fluids, especially in electrical equipment
- ◆ Target organs: liver, CNS, respiratory system, skin
- ◆ Health effects: skin ailments, chloracne, liver toxicity, cancer
- ◆ Monitoring: Physical exam focused on skin and liver, serum PCB levels, triglycerides, cholesterol, liver function



Pre-employment screening

- ❖ Determine an individual's fitness for duty, including the ability to work while wearing PPE
- ❖ Providing a baseline data set for comparison with future medical data



Determine fitness to perform work

- ◆ Work is often strenuous
- ◆ Often have to wear PPE
- ◆ May suffer heat stress



Recommended pre-employment screening elements

- ◆ Medical history
- ◆ Occupational history
- ◆ Physical examination
- ◆ Determination of fitness to work wearing PPE
- ◆ Baseline monitoring for specific exposures

Occupational/medical history

- ◆ Have employee fill out questionnaire
- ◆ Review answers before seeing worker
- ◆ Review past illnesses and chronic diseases
- ◆ Review symptoms
- ◆ Identify individuals who are vulnerable to particular substances
- ◆ Record relevant lifestyle habits

Physical exam

- ◆ Conduct a comprehensive exam of all body organs, focusing on the pulmonary, cardiovascular and musculoskeletal systems
- ◆ Note conditions that could increase susceptibility to heat stroke, such as obesity and physical conditioning
- ◆ Note conditions that affect respirator use, such as, facial scars, dentures, poor eyesight or perforated ear drums

Physical exam elements

- ◆ Height, weight, temperature, respiration, blood pressure
- ◆ Head, nose and throat exam
- ◆ Eyes, including vision, depth perception, color blindness
- ◆ Hearing including audiometric tests from 500 to 6,000 hertz
- ◆ Chest, heart and lungs
- ◆ Peripheral vascular system

Physical exam elements (Page 2)

- ◆ Abdomen and rectum
- ◆ Spine and other musculoskeletal system components
- ◆ Genitourinary system
- ◆ Skin and nervous system
- ◆ Blood tests
- ◆ Urinalysis
- ◆ Pulmonary function (if respirator is to be worn)
- ◆ EKG
- ◆ A 14x17 inch chest x-ray
- ◆ Specific chemicals of interest

Body function tests

◆ Liver:

- General: blood tests: total protein, albumin, globulin, total bilirubin
- Obstruction: enzyme tests: alkaline phosphatase
- Cell injury: enzyme tests: GGTP, LDH, SGOT, SGPT

◆ Kidney

- General: blood tests: blood urea nitrogen (BUN), creatinine, uric acid

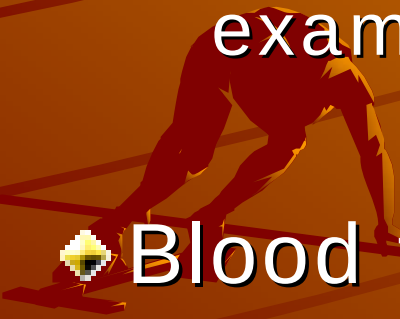
Body function tests (Page 2)

❖ Multiple systems and organs

- Urinalysis: color, appearance, specific gravity, pH, qualitative glucose, protein, bile, acetone, occult blood, microscopic examination of sediment

❖ Blood forming function

- Blood tests: CBC, WBC, RBC, HGB, HCT



Ability to work

- ◆ Disqualify individuals who are clearly unable to perform based on the medical history and physical exam
- ◆ Note limitations concerning the worker's ability to use PPE
- ◆ Provide additional testing for ability to wear PPE
- ◆ Base decision on individual's profile
- ◆ Make a written assessment of the worker's capacity to perform while wearing a respirator

Recommended periodic medical examination elements

- ◆ Yearly update of medical and occupational history
- ◆ Yearly physical examination
- ◆ Testing based on examination results, exposure and job class and task
- ◆ More frequent testing based on specific exposures

Periodic screening exams

- ◆ Interval medical history, emphasizing worker's interval exposures
- ◆ Physical exam
- ◆ Additional testing based upon the potential medical effects of exposure, such as:
 - Pulmonary function
 - Audiometric
 - Vision
 - Blood and urine

Recommended emergency treatment elements

- ◆ Provide emergency first aid kits
- ◆ Develop liaison with local hospital and medical specialists
- ◆ Arrange for decontamination of victims
- ◆ Arrange in advance for transport of victims
- ◆ Transfer medical records
- ◆ Give detail of incident and medical history to next care provider

Emergency treatment elements

- ◆ Train a team in first aid and CPR, including first aid for:
 - Explosion and burn injuries
 - Heat stress
 - Acute chemical toxicity
- ◆ Train site personnel in emergency decontamination procedures
- ◆ Predesignate roles and responsibilities for emergencies

Emergency treatment elements

(Page 2)

- ◆ Establish an emergency/first aid station on site capable of:
 - Stabilizing victims
 - General first aid
- ◆ Locate station in clean area adjacent to the decon station
- ◆ Provide a standard first aid kit, deluge showers, stretchers, portable water, ice, emergency eyewash, decon solutions, fire extinguishing blankets
- ◆ Restock supplies and equipment as needed

Emergency treatment elements (Page 3)

- ◆ Arrange for a physician who can be paged 24 hours a day
- ◆ Set up an on-call medical team
- ◆ Establish a heat stress monitoring protocol
- ◆ Make plan in advance for emergency transportation
- ◆ Post important phone numbers
- ◆ Provide maps and directions
- ◆ Make sure responders know the way to the nearest medical facility
- ◆ Establish a radio system
- ◆ Review emergency procedures daily

Indications of chemical exposure

Behavioral changes

Changes in skin color

Coughing

Drooling

Fatigue

Irritation of eyes, nose, skin
respiratory tract

Nausea

Sweating

Tightness in chest

Breathing difficulties

Coordination
difficulties

Dizziness

Diarrhea

Irritability

Headache

Light-headedness

Sneezing

Tearing

Vomiting

Indications of heat stress

Clammy skin

Dizziness

Fatigue

Light-headedness

Profuse sweating

Weak pulse

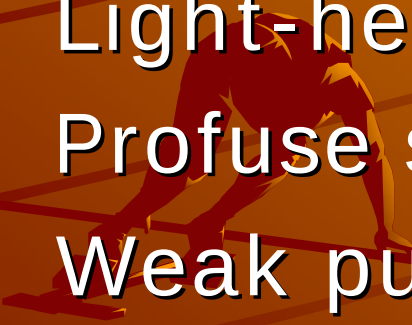
Confusion

Fainting

Heat rash

Nausea

Slurred speech



Indications of heat stroke

Confusion

Hot skin

Incoherent speech

Sweating stops

Convulsions

High temperature

Staggering gait

Unconsciousness



Recommended non-emergency treatment elements

- ◆ Develop mechanism for non-emergency health care
 - Provide for evaluation of any job-related symptoms or illnesses
 - Provide for treatment of any job-related illnesses that may put the worker at risk because of task requirements
 - Keep a copy of medical records at the site and the nearest hospital or have them transported with victim

Program review

- ◆ Ascertain that each accident or illness was promptly investigated to determine cause and make necessary changes in health and safety procedures
- ◆ Evaluate the efficacy of specific medical testing based on potential site exposures
- ◆ Add or delete medical tests as suggested by current industrial hygiene and environmental data
- ◆ Review potential exposures and SSP at all sites to determine if additional testing is required
- ◆ Review emergency treatment procedures and update list of emergency contacts

Lesson 10

TRAINING REQUIREMENTS



Training

- ◆ Training programs

- ◆ Records



Training (Page 2)

- ◆ Personnel actively involved in cleanup activities must be thoroughly familiar with programs and procedures contained in the SSP
- ◆ Visitors to a site must receive adequate training on hazard recognition and on the site's SOP's to enable them to conduct their visit safely

Training (Page 3)

- ◆ The level of training should be consistent with the worker's job function and responsibilities
- ◆ Program should involve both classroom instruction in a wide range of health and safety topics and hands-on practice
- ◆ Hands-on practice should include drills in the field that simulate site activities and emergencies
- ◆ Clear, concise language should be used
- ◆ A variety of teaching aids should be used and lecturer classes should be interspersed with class participation and hands-on training

Training programs

◆ Objectives:

- To make workers aware of the potential hazards they may encounter
- To provide the knowledge and skills necessary to perform the work with minimal risk to worker health and safety
- To make workers aware of the purpose and limitations of safety equipment
- To ensure that workers can safely avoid or escape from emergencies



Training programs (Page 2)

- ◆ Based on job type
 - General site workers
 - Onsite management and supervisors
 - Health and safety staff
 - Visitors



General site workers

- ◆ Site safety plan
- ◆ Site work practices
- ◆ Nature of anticipated hazards
- ◆ Handling emergencies and self-rescue
- ◆ Rules and regulations for vehicle use
- ◆ Safe use of field equipment
- ◆ Handling, storage and transportation of hazardous materials
- ◆ Employee rights and responsibilities
- ◆ Use, care and limitations of PPE

General site workers (Page 2)

- ◆ Safe sampling techniques
- ◆ Site surveillance
- ◆ Use and decontamination of PPE
- ◆ Use of instruments to measure explosivity, radioactivity, etc.
- ◆ Safe use of specialized equipment
- ◆ Topics specific to identified site activities

Onsite management and supervisors

- ◆ Same as general site workers
- ◆ Management of hazardous waste site cleanup operations
- ◆ Management of site work zones
- ◆ How to communicate to the press and local community



Health and safety staff

- ◆ Same as general site workers
- ◆ Same as site supervisors
- ◆ Advanced training in health and safety issues, policies and techniques



Visitors

- ◆ Receive a safety briefing
- ◆ Kept out of exclusion zone unless they have received the same training as a general site worker



Training topics

◆ Biology, chemistry and physics of hazardous materials

- Chemical and physical properties
- Chemical reactions
- Chemical compatibilities

◆ Toxicology

- Dosage
- Route of exposure
- Toxic effects
- IDLH, PEL, REL and TLV values



Training topics (Page 2)

◆ Industrial hygiene

- Selection and monitoring of PPE and equipment
- Calculation of doses and exposure levels
- Evaluation of hazards
- Selection of worker health and safety protective measures

◆ Rights and responsibilities of workers under OSHA

Training topics (Page 3)

◆ Monitoring equipment

- Functions, capabilities, selection use, limitations and maintenance

◆ Hazard evaluation

- Techniques of sampling and assessment
- Evaluation of field and lab results
- Risk assessment

◆ SSP



Training topics (Page 4)

◆ SOP's

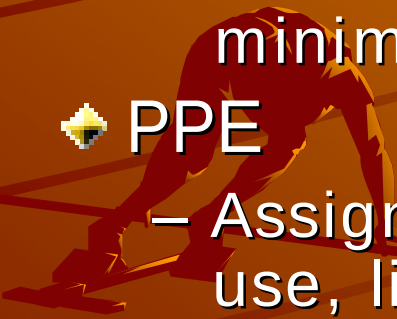
- Hands-on practice
- Development and compliance

◆ Engineering controls

- The use, barriers, isolation and distance to minimize hazards

◆ PPE

- Assignment, sizing, fit-testing, maintenance, use, limitations and hands-on training
- Selection of PPE
- Ergonomics



Training topics (Page 5)

◆ Medical program

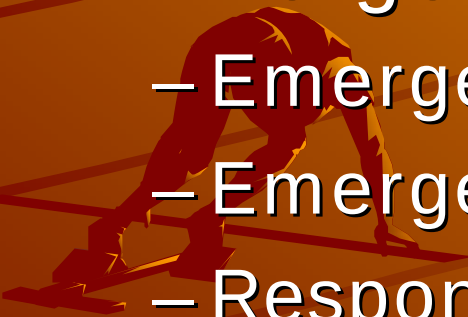
- Medical monitoring, first aid, stress recognition
- Advanced first aid, CPR, emergency drills
- Design, planning and implementation

◆ Decontamination

- Hands-on training using simulated field conditions
- Design and maintenance

Training topics (Page 6)

- ◆ Legal and regulatory aspects
 - Applicable OSHA, EPA, DOT, etc. regulations
- ◆ Emergencies
 - Emergency help and self-rescue
 - Emergency drills
 - Response to emergencies
 - Follow-up investigation and documentation



Training records

- ◆ Maintain a record in each employee's file
- ◆ Maintain a record that the employee's training is:
 - As appropriate to their assigned task
 - Current and up to date

Lesson 11

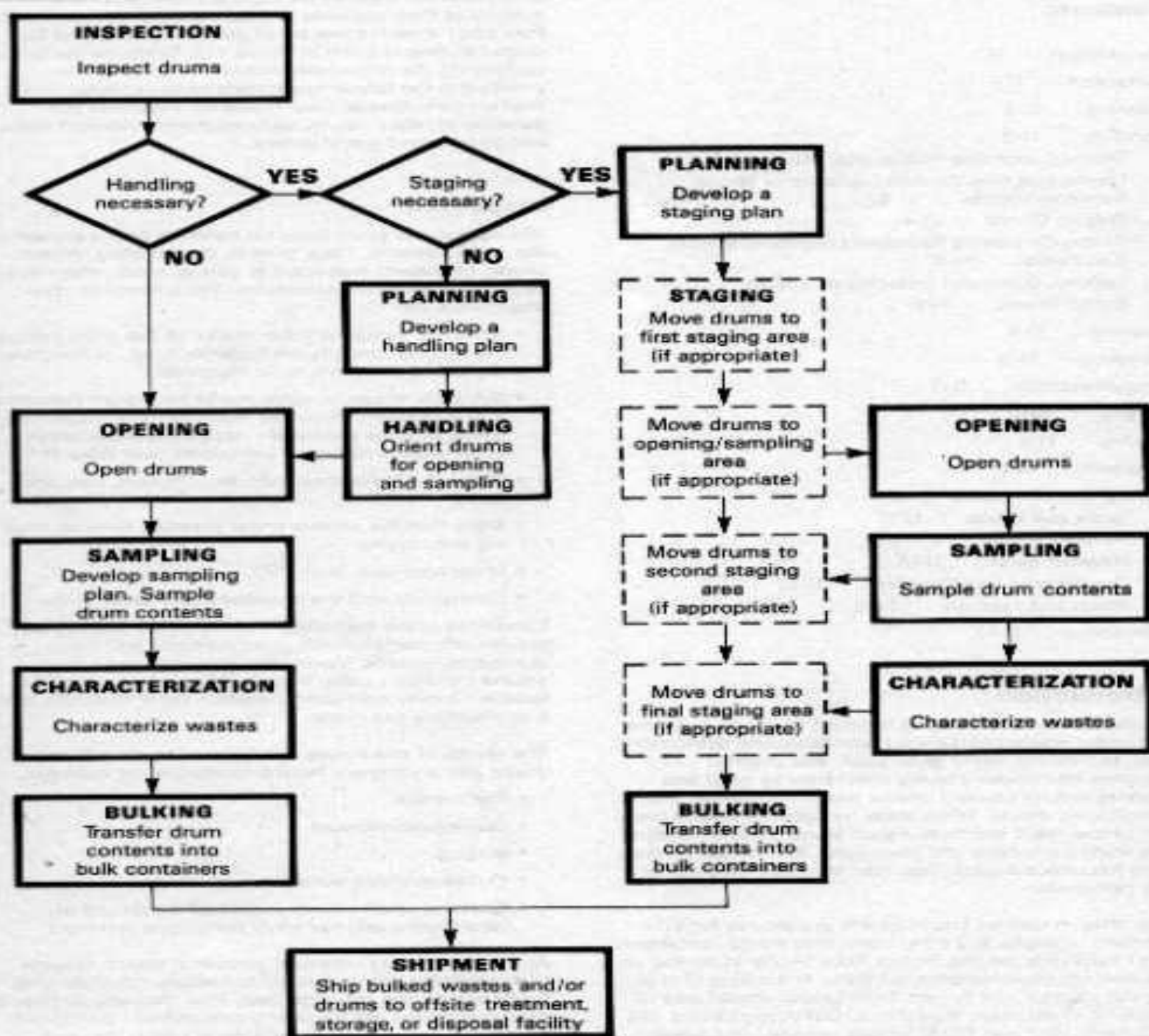
HANDLING DRUMS AND CONTAINERS



Handling drums and containers

- ◆ Inspection
- ◆ Planning
- ◆ Handling
- ◆ Opening
- ◆ Sampling
- ◆ Characterization
- ◆ Staging
- ◆ Bulking
- ◆ Shipment
- ◆ Special containers

Drum handling chart

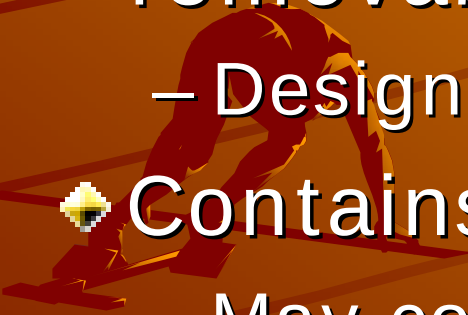


Drum types

- ◆ Polyethylene or PVC-lined
 - Often contain strong acids or bases
- ◆ Exotic metal (aluminum, nickel, stainless steel)
 - Usually contain extremely hazardous materials
- ◆ Single-walled drums used as a pressure vessel
 - Usually contain reactive, flammable or explosive substances
- ◆ Lab packs
 - Contains many varied chemicals that are sometimes incompatible
- ◆ Cardboard fiber

Drum lid types

- ◆ Whole lid removable
 - Designed to contain solid materials
- ◆ Lid has a bung (may be whole lid removable or not removable at all)
 - Designed to contain a liquid
- ◆ Contains a liner
 - May contain a highly corrosive or otherwise hazardous material



Inspection

- ◆ Appropriate procedures often depends on contents
- ◆ Visually inspect drums and containers to determine content, if possible
- ◆ Look for condition immediately adjacent to drum area
- ◆ Monitor atmosphere around the area using a variety of instruments
 - Gamma radiation
 - Organic vapor monitors
 - Combustible gas meter

Inspection (Page 2)

- ◆ If there are no labels, assume the drum contains hazardous materials
- ◆ Based on survey, classify drums based on hazards, then contents
- ◆ Remember that drums may be mislabeled
- ◆ Use ground-penetrating systems to search for buried drums
 - Ground penetrating radar
 - Electromagnetic wave
 - Electrical resistivity
 - Magnetometry
 - Metal detection



Look for

- ◆ Symbols, words, or other marks on the drum that identifies contents and their hazards
- ◆ Symbols, words or other marks that indicates it's a lab pack
- ◆ Signs of deterioration
- ◆ Signs that the drum is over pressured
- ◆ Drum type
- ◆ Configuration of the drumhead

Typical drum hazard classes

- ◆ Radioactive
- ◆ Leaking/deteriorated
- ◆ Bulging
- ◆ Explosive/shock sensitive
- ◆ Lab packs

Planning

- ◆ A preliminary plan should be prepared that details:
 - What hazards are present
 - The appropriate response to the drums
 - Which drums need to be moved in order to open for sampling
- ◆ Plan specifies
 - The extent of handling
 - The personnel selected for the job
 - The most appropriate procedures based on the hazards associated with the probable drum contents
- ◆ Plan should be revised with new information



Handling

◆ Purpose:

- Respond to obvious problems that might impair worker safety
- Unstack and orient drums for sampling
- If necessary, organize drums into different areas on site to facilitate characterization and remedial action

◆ Handling may or may not be necessary, depending on how the drums are positioned at a site

◆ Drums should be handled only if necessary to prevent accidents



Handling (Page 2)

- ◆ Personnel should be warned of the hazards of drum handling before work begins
- ◆ Respond to newly discovered hazards as they occur
- ◆ Keep an adequate supply of absorbent on hand to respond to leaks
- ◆ If there is a potential for a major spill, berm the work area to prevent spreading
- ◆ Have trained spill responders ready

Drum handling equipment

- ◆ A drum grappler attached to a hydraulic excavator or backhoe (preferred option)
- ◆ A small front end loader
- ◆ A rough terrain forklift
- ◆ A roller conveyor equipped with solid rollers
- ◆ Drum carts
- ◆ Can be moved manually

Handling procedures

- ❖ Train personnel in proper lifting and moving techniques to prevent back injuries
- ❖ Make sure vehicle selected has sufficient rated load capacity to handle anticipated loads and make sure the vehicle can operate properly on the available road surface
- ❖ Air condition the cabs of vehicles to increase operator efficiency, protect the operator with heavy splash shields
- ❖ Have overpacks ready before any attempt is made to move drums

Handling procedures (Page 2)

- ◆ Supply operators with appropriate respiratory protection equipment
- ◆ Before moving anything, determine the most appropriate sequence in which various drums and other containers should be moved
- ◆ Exercise extreme caution in handling drums that are not intact and tightly sealed
- ◆ Ensure that operators have a clear view of the roadway when carrying drums

Radioactive drums

- ◆ If a drum is found to contain radioactive materials, do not move it, wait for specialized personnel
- ◆ Call a health physicist for advice



Explosive/shock sensitive drums

- ❖ Seek specialized assistance before any handling
- ❖ Handle these drums with extreme caution
- ❖ Prior to handling, make sure all non-essential personnel have been moved to a safe distance
- ❖ Use a grappler unit constructed for explosive containers
- ❖ Palletize drums prior to transport
- ❖ Use an audible siren signal system
- ❖ Maintain continuous communications until operations are completed

Bulging drums

- ◆ Pressurized drums are extremely hazardous
- ◆ Do not move drums that may be under internal pressure
- ◆ Use a grapppler designed for explosive containers to move drums



Lab packs

- ◆ Contain small containers surrounded by absorbent
- ◆ Prior to handling or transporting, make sure all non-essential personnel have been moved to a safe area
- ◆ Use a grappler constructed for explosive containers
- ◆ Maintain continuous communications until operations are completed
- ◆ Have a chemist inspect, classify and segregate containers inside a lab pack
- ◆ If crystalline material is around opening handle as shock-sensitive
- ◆ Palletize prior to transport and secure drums to pallet

Leaking, open and deteriorated drums

- ❖ If the drum cannot be moved without rupture, immediately transfer contents to a sound drum using a pump designed for the contents
- ❖ Use a drum grappler and place in overpack the following:
 - Leaking drums that contain sludges or semi-solids
 - Open drums that contain liquid or solid waste
 - Deteriorated drums that can be moved without rupture

Buried drums

- ◆ Prior to initiating subsurface excavation, estimate location and depth of drums
- ◆ Remove soil with great caution to minimize the potential for drum rupture
- ◆ Have a dry chemical fire extinguisher available

Drum opening

- ◆ Drums are usually opened and sample in place during site investigations
- ◆ Remedial and emergency operations may require a separate drum opening area
- ◆ Drum opening procedures are the same in either situation

Drum opening procedures

- ❖ Place a bank of air cylinders outside the work area when using a supplied air respiratory system
- ❖ Keep personnel a safe distance from the drums being opened or place explosive-resistant shields between them and the drums
- ❖ Locate drum opening equipment controls, monitoring equipment and fire suppression systems behind an explosion-resistant plastic shield

Drum opening procedures

(Page 2)

- ◆ Monitor continuously during opening
- ◆ Use the following remote-controlled devices for opening drums:
 - Pneumatically operated impact wrench to remove bungs
 - Hydraulically or pneumatically operated drum piercers
 - Backhoes with bronze spikes for penetrating drum tops at a large scale operation

Drum opening procedures (Page 3)

- ◆ Do not use picks, chisels or firearms to open drums
- ◆ Hang or balance the drum opening equipment to minimize worker exertion
- ◆ Perform all steps slowly on a bulging drum
- ◆ Relieve excess pressure prior to opening, either remotely or behind an explosive-resistant shield



Drum opening procedures

(Page 4)

- ◆ Open exotic metal drums and polyethylene or PVC-lined drums through the bung by removal or drilling
- ◆ Do not open or sample individual lab pack containers
- ◆ Reseal open bungs and all openings as soon as possible or place the drum in an overpack.
- ◆ Decontaminate all equipment after each use to avoid mixing incompatible wastes

Sampling drums

- ◆ Can be the most hazardous activity because of direct contact with the contaminants are required
- ◆ Develop a sampling plan
- ◆ Use special precautions when sampling manually

Drum sampling plan

- ◆ Research background information about the wastes
- ◆ Determine which drums should be sampled
- ◆ Select the appropriate sampling devices and containers
- ◆ Develop a sampling plan that outlines the number, volume and locations of samples
- ◆ Develop sampling SOPs
- ◆ Have a trained health and safety professional determine the PPE required

Manual sampling

- ◆ Keep sampling personnel at a safe distance while drums are being opened
- ◆ Do not lean over drums
- ◆ Cover the drum tops with plastic sheeting
- ◆ Never stand on drums
- ◆ Obtain samples with either glass rods or vacuum pumps



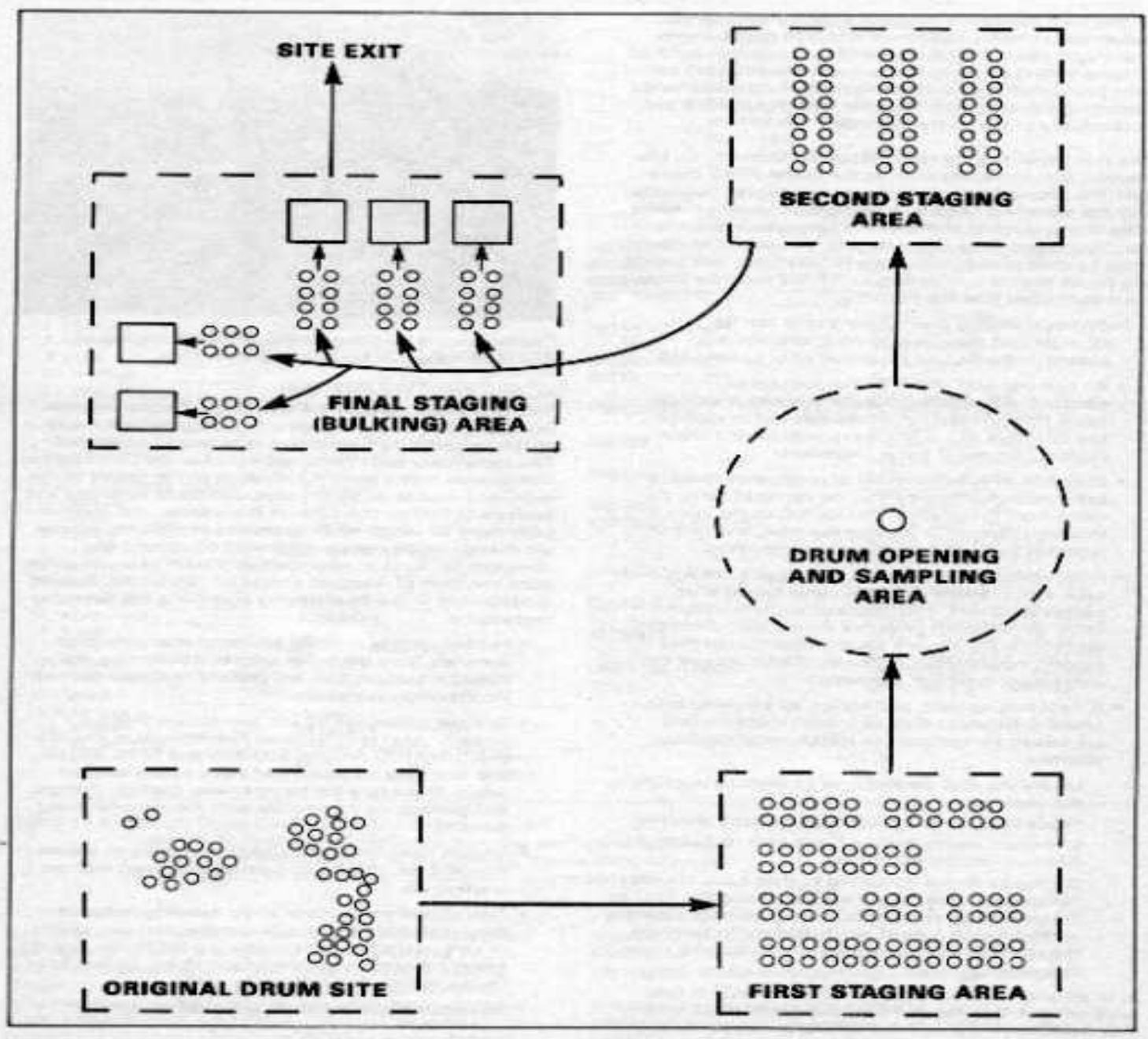
Drum characterization

- ◆ Goal is to obtain the data necessary to determine how to safely and efficiently package and transport the wastes for treatment and/or disposal
- ◆ Standard tests should be used to classify the waste into general categories:
 - Auto-reactives
 - Water reactives
 - Inorganic acids
 - Organic acids
 - Heavy metals
 - Pesticides
 - Cyanides
 - Inorganic oxidizers
 - Organic oxidizers
- ◆ Characterize using an onsite lab, if available
- ◆ Package samples following DOT regulations

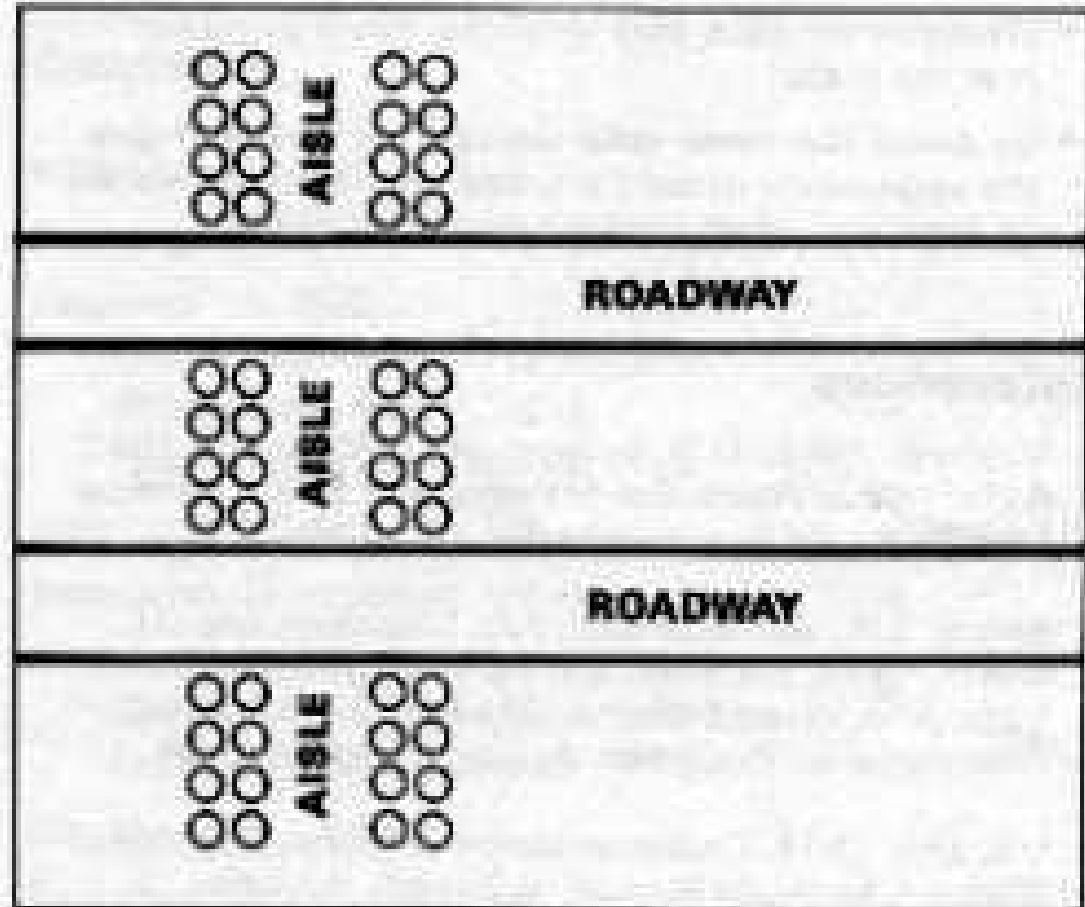
Drum staging

- ◆ Drums may need to be staged to facilitate characterization and remedial action
- ◆ Drums may need to be staged to protect them from hazardous site conditions
- ◆ Trade off between increased hazards associated with handling and decreased hazards associated with the enhanced organization and accessibility of the waste materials
- ◆ Number of staging areas depends on site-specific conditions such as scope, accessibility and perceived hazards
- ◆ Stage drums two wide by two rows per area and space the rows 7-8 feet apart

Drum staging diagram



Drum storage diagram



Stages of drum handling

◆ Initial stage

- Drums are organized by type, size, and suspected contents and stored prior to sampling

◆ Opening area

- Drum are opened, sampled and resealed

◆ Sampling area

- Used in large scale operations for drum sampling

Stages of drum handling

(Page 2)

- ◆ Second staging (holding) area
 - Temporary storage area pending characterization that contains no unsealed drums
- ◆ Final staging (bulking) area
 - Bulking of characterized drums occur
 - ◆ Locate the area as close to the site's exit
 - ◆ Grade the area and cover it with plastic sheeting
 - ◆ Construct 1-foot high dikes around it
 - ◆ Segregate drums according to basic chemical categories



Drum bulking

- ❖ Wastes that have been characterized as similar are often mixed together and placed in bulk containers for shipment
- ❖ Increase efficiency and reduces costs
- ❖ Performed only after thorough characterization has occurred
- ❖ May require compatibility testing before bulking

Bulking procedures

- ◆ Inspect each tank trailer and remove any residual materials prior to transferring any bulked materials
- ◆ Use pumps that are rated for specific hazardous materials
- ◆ Inspect hose lines before beginning work to ensure that all hoses, fittings and valves are intact
- ◆ Take special precautions when handling hoses
- ◆ Store flammable liquids in approved containers

Drum shipment

- ◆ Follow all US DOT and EPA rules and regulations
- ◆ Locate final staging area as close to the exit as possible
- ◆ Prepare a circulation (traffic) plan that minimizes conflict between cleanup teams and waste haulers
- ◆ Provide adequate area for onsite and hauling vehicles to turn around
- ◆ Stage hauling vehicles in a safe area until ready

Drum shipment (Page 2)

- ◆ Outfit driver with appropriate PPE
- ◆ Tightly seal all drums prior to loading
- ◆ Overpack leaking or deteriorated drums
- ◆ Make sure truck bed and walls are clean and smooth
- ◆ Keep bulk solids several inches below the top of the trailer
- ◆ Weigh vehicles periodically to ensure they meet road limits
- ◆ Decon vehicle tires prior to leaving site
- ◆ Check for release of dust or vapor emissions
- ◆ Develop procedures for responding to spills

Tanks and vaults

- ◆ When opening a tank or vault follow the same procedures as a sealed drum
- ◆ Guard manholes or access portals to prevent personnel from falling in
- ◆ Identify contents through sampling and analysis
- ◆ Empty and decon the tank or vault before removal
- ◆ Use confined space entry procedures when entering

Confined space entering

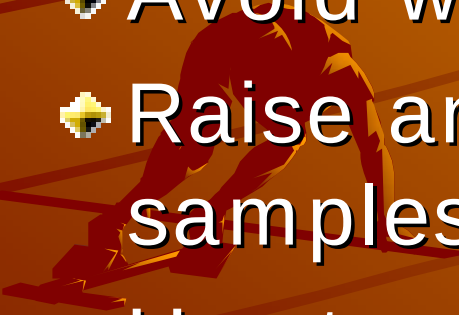
- ◆ Ventilate tank or vault thoroughly prior to entry
- ◆ Disconnect connecting pipelines
- ◆ Take air samples to prove absence of flammable, combustible, oxygen deficient atmospheres
- ◆ Equip entry team with appropriate respiratory systems, safety harnesses, protective clothing and ropes

Confined space entering (Page 2)

- ◆ Equip a safety observer with appropriate protective equipment
- ◆ Establish lifeline signals prior to entry
- ◆ Have an additional person available in the vicinity to assist the safety observer
- ◆ Instruct the safety observer not to enter the space until additional personnel are on scene

Vacuum truck entry

- ◆ Wear appropriate PPE
- ◆ Use mobile steps or suitable scaffolding
- ◆ Avoid walking across truck catwalk
- ◆ Raise and lower equipment and samples in carriers
- ◆ Use two hands while climbing
- ◆ Sample from the top of the vehicle



Elevated tanks

- 
- ◆ Use a safety line and harness
 - ◆ Maintain ladders and railings in accordance with 29 CFR 1910 Subpart D

Compressed gas cylinders

- ◆ Obtain expert assistance in moving and disposing of cylinders
- ◆ Handle compressed gas cylinders with extreme caution
- ◆ Record the ID numbers on the cylinder to aid in characterizing them
- ◆ Secure them in accordance with OSHA regulations



Ponds and lagoons

- ◆ Provide necessary safety gear such as lifeboats, tag lines, railings, nets, safety harnesses and floatation gear when sampling
- ◆ Stay on shore
- ◆ Be aware that some solid wastes may float and give the appearance of solid cracked mud
- ◆ Be careful when working along shore lines

Lesson 12

DECONTAMINATION



Decontamination

- ❖ Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel and equipment
- ❖ It is critical to health and safety at hazardous waste sites
- ❖ It protects the workers from hazardous substances that may contaminate and eventually permeate protective clothing, respiratory equipment, tools, vehicles, and other equipment used on site

Decontamination (Page 2)

- ◆ It minimizes the transfer of harmful materials into clean areas
- ◆ It helps prevent the mixing of incompatible chemicals
- ◆ It protects the community by preventing uncontrolled transportation of contaminants from the site



Decontamination (Page 3)

- ◆ There are many types of contamination encountered at the site
- ◆ Many factors influence the extent of contamination
- ◆ There are methods for preventing or reducing contamination
- ◆ There are general guidelines for designing and selecting decontamination procedures at a site

Decontamination Plan

- ◆ Determine the number and layout of decon stations
- ◆ Determine the decon equipment needed
- ◆ Determine appropriate decon methods
- ◆ Establish procedures to prevent contamination of clean area
- ◆ Establish methods and procedures to minimize worker contact with contaminants
- ◆ Establish methods for disposing of clothing and equipment that are not completely deconned
- ◆ Establish sampling and verification procedures for identifying cleaned items

Prevention of contamination

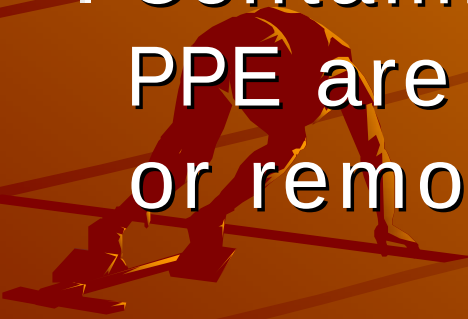
- ◆ Establish standard operating procedures that minimize contact with waste
- ◆ Stress work practices that minimize contact with hazardous substances
- ◆ Use remote sampling, handling and container opening techniques
- ◆ Protect monitoring and sampling instruments by covering them with plastic bags

Prevention (Page 2)

- ◆ Wear disposable outer garments and use disposable equipment where appropriate
- ◆ Cover equipment and tools with a strippable coating which can be removed during decontamination
- ◆ Encase the source of contamination with plastic sheeting or overpacks
- ◆ Maximize worker protection
- ◆ Train personnel on SOPs

Types of contamination

- ◆ Contaminants can be located on the surface of PPE or permeated into the PPE
- ◆ Contaminants that have permeated PPE are nearly impossible to detect or remove



Factors affecting permeation

- ◆ Contact time with contaminants
- ◆ Concentration of contaminants
- ◆ Temperature which increases permeation as it increases
- ◆ Size of contaminant molecules
- ◆ Physical states of waste

Decontamination methods

- ◆ Physical removal
- ◆ Chemical removal



Physical removal methods

- ◆ Dislodging or displacement of contaminants with air pressure
- ◆ Rinsing with water, using pressurized or gravity flow
- ◆ Wiping/scrubbing/scraping
- ◆ Evaporation/vaporization
- ◆ Steam jets
- ◆ Disposal of PPE and equipment

Loose contamination

- ◆ Dusts and vapors that cling to equipment and PPE or become trapped in small openings
- ◆ Water and liquid rinses are effective
- ◆ Electrostatically attached materials can be enhanced by coating the clothing or equipment with an anti-static solution

Adhering contaminants

◆ Methods of removal include:

- Scraping
- Brushing
- Wiping



Volatile liquids

- ❖ Volatile contaminants can be removed by evaporation followed by a water rinse
- ❖ Evaporation can be enhanced by steam jets
- ❖ Care must be taken to prevent worker inhalation of the vaporized chemicals

Chemical removal

- ◆ Chemical leaching/extraction

- ◆ Inactivation

 - Chemical detoxification

 - ◆ Halogen stripping

 - ◆ Neutralization

 - ◆ Oxidation/reduction

 - ◆ Thermal degradation

 - Disinfection/sterilization

 - ◆ Chemical disinfection

 - ◆ Dry heat sterilization

 - ◆ Gas/vapor sterilization

 - ◆ Irradiation

 - ◆ Steam sterilization



Dissolving contaminants

- ◆ Chemical removal of surface contaminants can be accomplished by dissolving them in a solvent
- ◆ The solvent must be compatible with the equipment being deconned
- ◆ Care must be taken when using organic solvents that may be flammable
- ◆ Halogenated solvents are incompatible with PPE

Typical solvents

◆ Water:

- Low chain hydrocarbons
- Inorganic compounds
- Salts
- Some organic acids and other polar compounds

◆ Dilute acids

- Basic (caustic) compounds
- Amines
- Hydrazines

Typical solvents (Page 2)

◆ Dilute bases (detergent, soap)

- Acidic compounds
- Phenols
- Thiols
- Nitro and sulfonic compounds

◆ Organic solvents (alcohols, ethers, ketones, aromatics, straight chain alkanes, petroleum products)

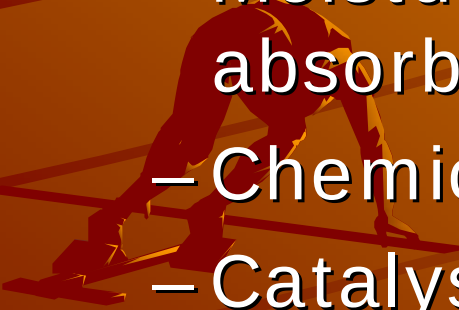
- Non-polar compounds

Surfactants

- ◆ Surfactants augment physical cleaning methods by reducing adhesion forces between the contaminants and the surface being cleaned
- ◆ Household detergents are the most common surfactants
- ◆ Some detergents can be used with organic solvents to improve the dissolving and dispersal of contaminants
- ◆ Alconox is often used for sampling decon

Solidification

- ❖ Solidifying liquid or gel contaminants can enhance their physical removal
- ❖ The mechanisms are:
 - Moisture removal through the use of absorbents
 - Chemical reactions via polymerization
 - Catalysts and chemical reagents
 - Freezing using ice water



Rinsing

- ◆ Rinsing removes contaminants through dilution, physical attraction, and solubilization
- ◆ Multiple rinses with clean solutions remove more contaminants than a single rinse with the same volume of solution
- ◆ Continuous rinsing will remove more contaminants than multiple rinsing

Disinfection/sterilization

- ◆ Chemical disinfectants are a practical means of inactivating infectious agents
- ◆ Disposable PPE is preferred in infectious environments

Factors affecting decon method

- 
- ◆ Cost
 - ◆ Availability
 - ◆ Ease of implementation

Testing decon effectiveness

◆ Visual observation

- Natural light signs of ineffective decon

- ◆ Discolorations

- ◆ Stains

- ◆ Corrosive effects

- ◆ Visible dirt

- ◆ Alterations in clothing fabric

- Ultraviolet light

- ◆ Polycyclic aromatic hydrocarbons

- ◆ Used on clothing, skin, and equipment

- ◆ Can cause cancer



Testing decon effectiveness (Page 2)

◆ Wipe sampling

- After the fact indications
- Use dry or wet cloth, glass fiber filter paper, swab to wipe surface being cleaned, then analyzed in lab

◆ Cleaning solution analysis

- Analyze contaminants in solution using lab

◆ Testing for permeation

- Take pieces of garment to lab and test for chemicals

Health and safety hazards

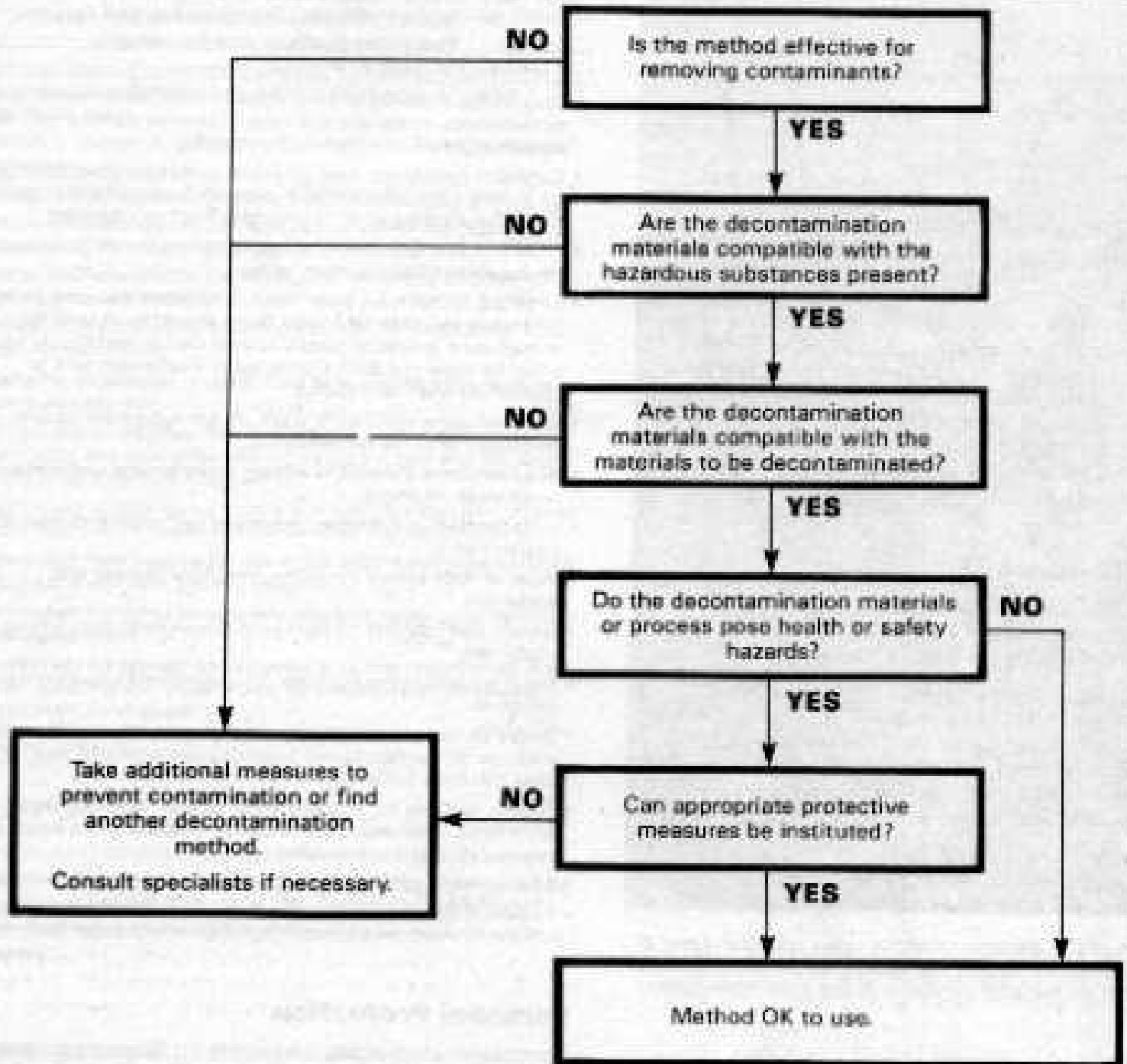
◆ Decon methods may:

- Be incompatible with the hazardous substances being removed
- Be incompatible with the clothing or equipment being deconned
- Pose a direct hazard to workers

◆ Evaluate chemical and physical compatibility before using

◆ Any decon method that permeates, degrades, damages, or otherwise impairs the safe functioning of PPE should not be used

Decision
aid for
decon
methods



Decon facility design

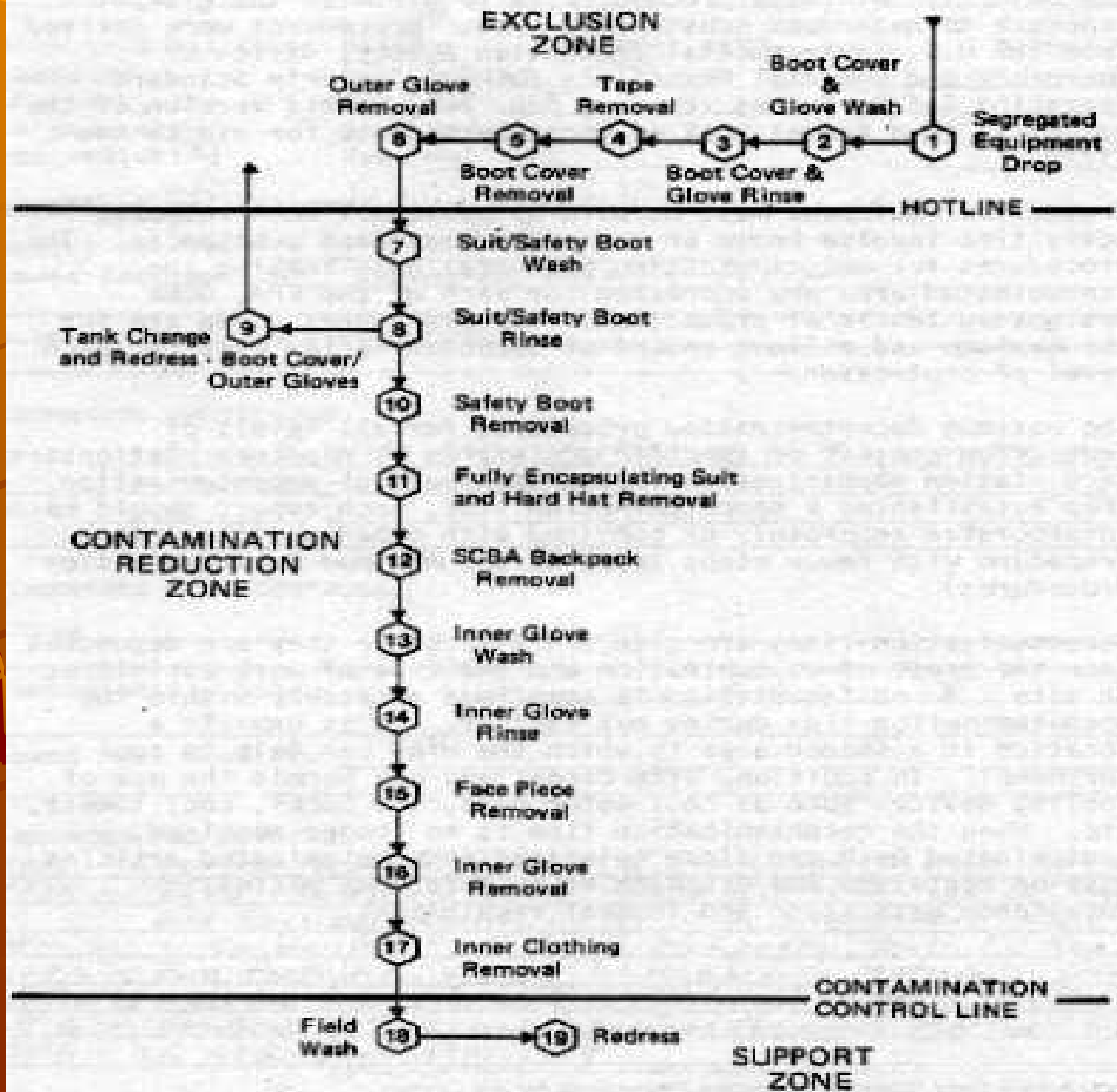
- ◆ Locate in CRZ
- ◆ Must be organized and reduce contaminants by levels from the most to the least contaminated
- ◆ Stations should be separated physically to prevent cross contamination
- ◆ Stations should be arranged in order of decreasing contamination
- ◆ Separate flow patterns should be set up to isolate workers from different contamination zones

Design (Page 2)

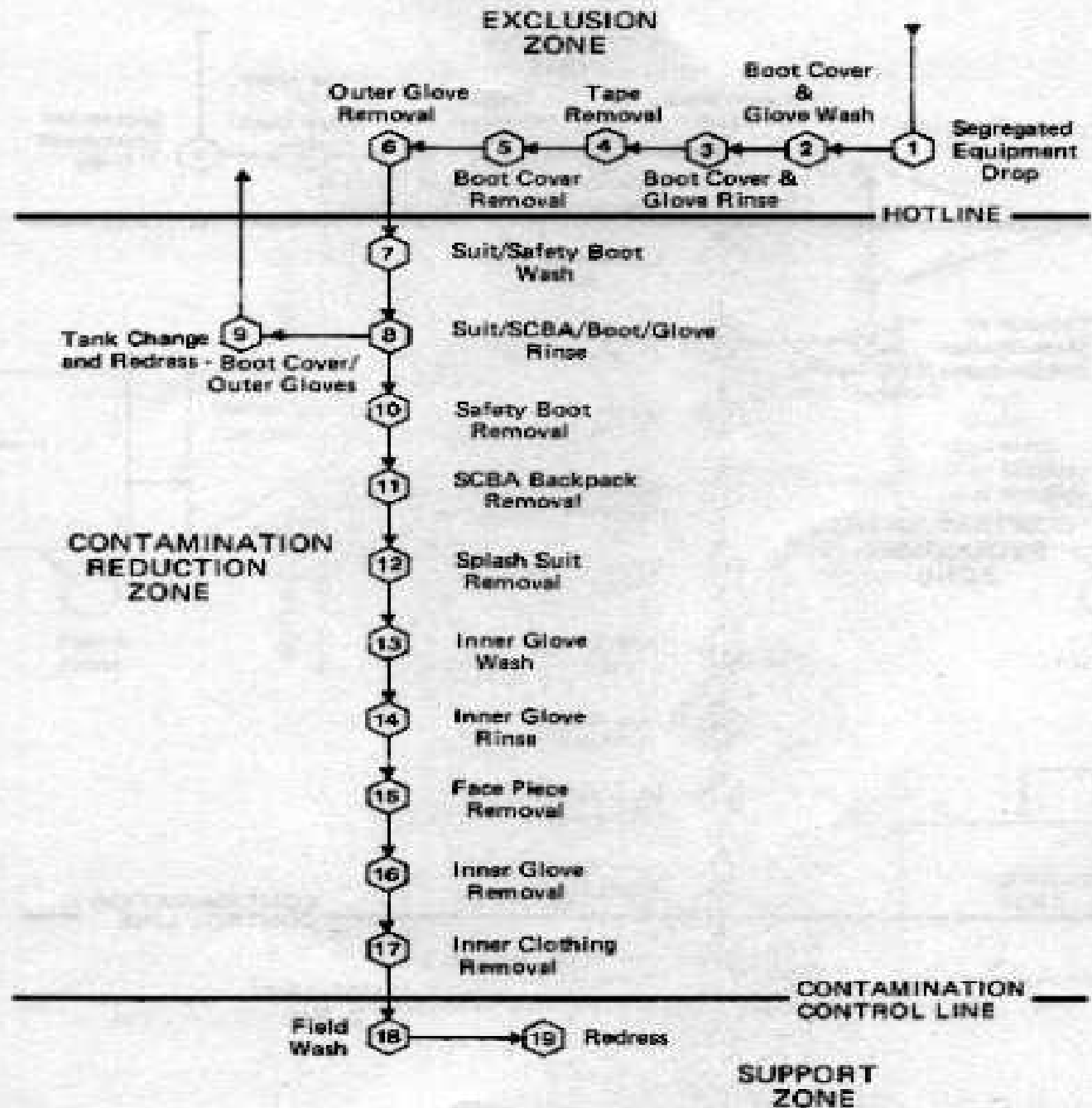
- ◆ Entry and exit points should be conspicuously marked
- ◆ Dressing areas should be separate from redressing areas
- ◆ Personnel entering clean areas should be completely deconned

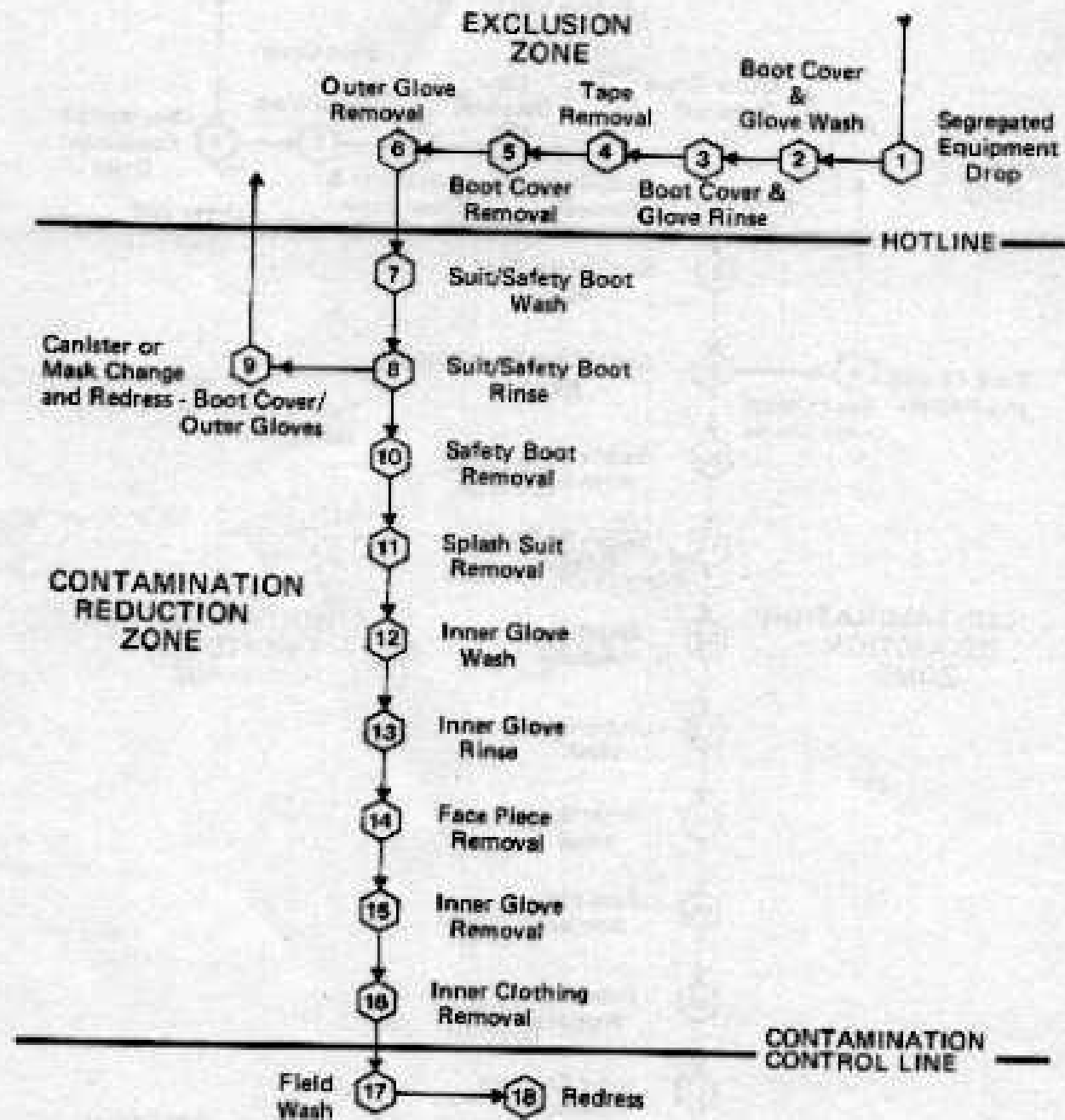


Level A
Max decon

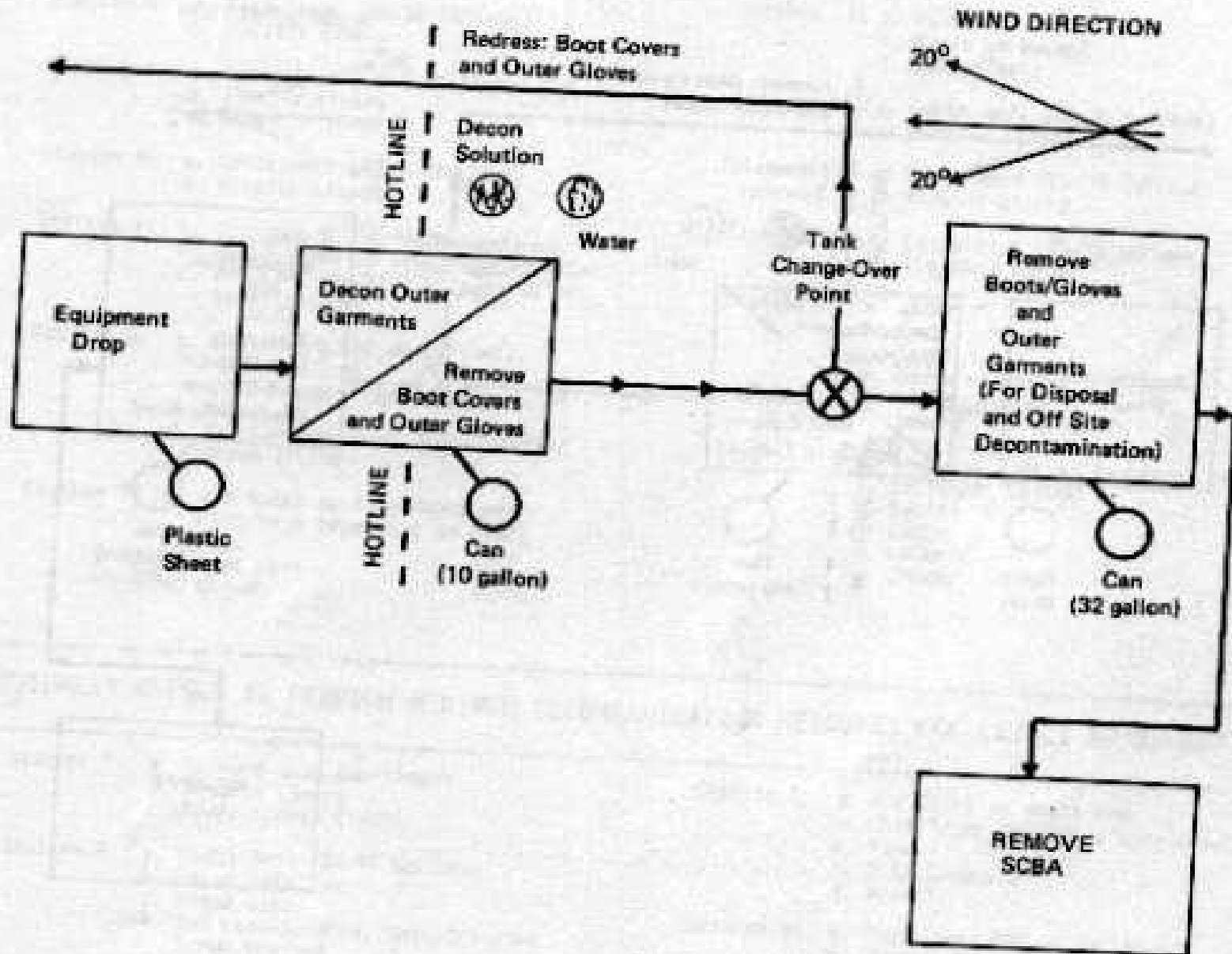


Level B
max
decon



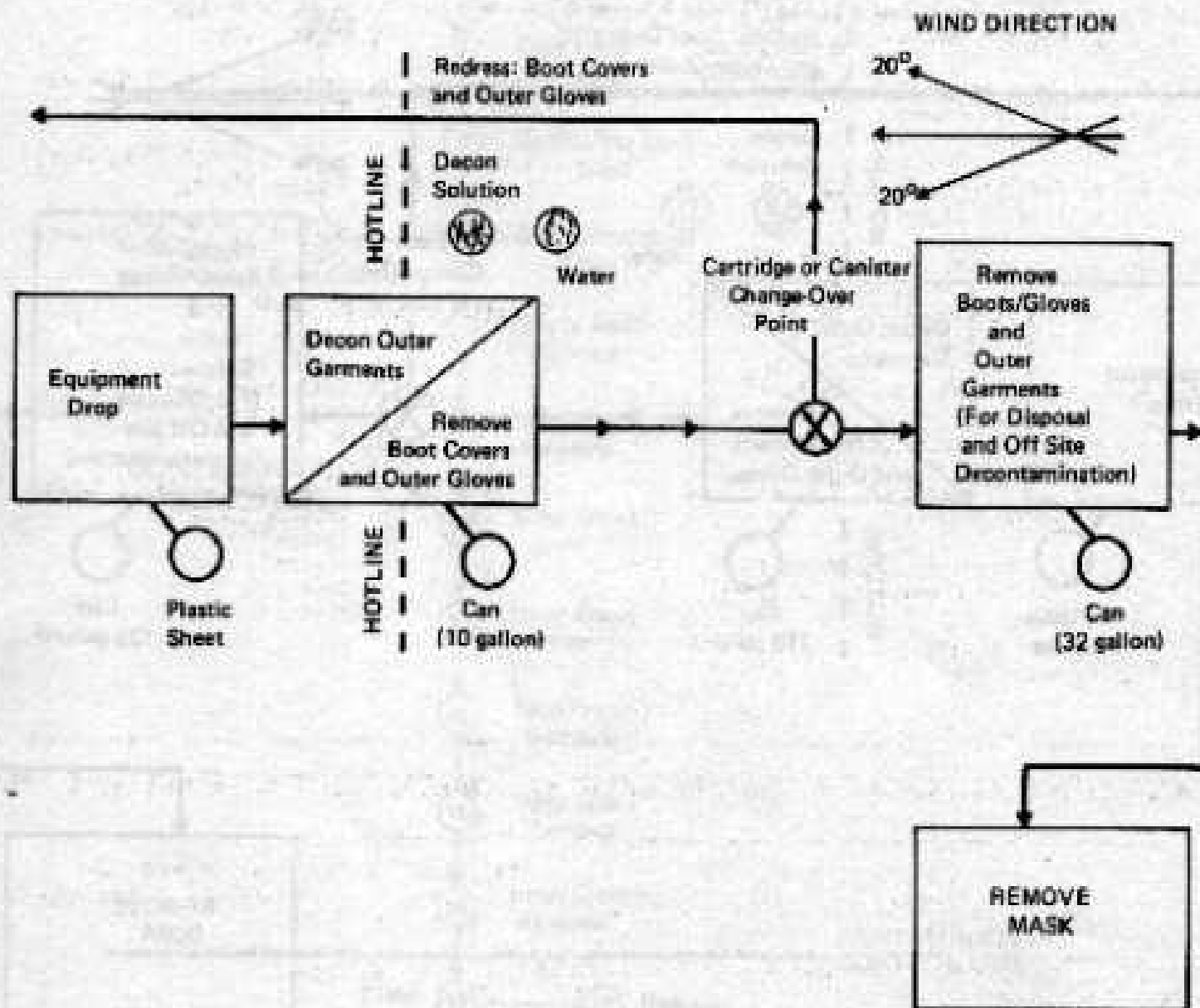


Level C
max
decon



Level
A,B
min
decon

Level C
min
decon



Factors affecting level and type of decon

- ◆ Chemical, physical and toxicological properties of contaminants
- ◆ Pathogenicity of infectious wastes
- ◆ Amount, location and containment of contaminants
- ◆ Potential for and location of exposure based on assigned worker duties, activities and functions

Factors (Page 2)

- ◆ Potential for wastes to degrade, permeate, or penetrate materials
- ◆ Proximity of incompatible wastes
- ◆ Movement of personnel and/or equipment among different zones
- ◆ Emergencies
- ◆ Methods available for protecting workers during decon

Recommended equipment for decon of personnel and PPE

- ◆ Drop clothes of plastic or other suitable materials
- ◆ Collection containers, such as drums, lined trash cans
- ◆ Lined boxes with absorbents for wiping
- ◆ Large galvanized tubs, stock tanks, or children's wading pools
- ◆ Wash solutions based on contaminants
- ◆ Rinse solutions based on contaminants
- ◆ Long handled soft-bristled brushes
- ◆ Paper or cloth towels for drying

Personnel and PPE decon

(Page 2)

- ◆ Lockers and cabinets for storing deconned clothing
- ◆ Metal or plastic cans or drums for contaminated rinses
- ◆ Plastic sheeting, sealed pads with drains, or other appropriate methods for containing and collecting contaminated wash and rinse solutions
- ◆ Shower facilities
- ◆ Soap and wash solution, wash cloths and towels for personnel

Recommended decon for heavy equipment

- ◆ Storage tanks of appropriate size
- ◆ Drains or pumps for collection of contaminated rinse and solution
- ◆ Long handled brushes
- ◆ Wash solution selected for contaminants
- ◆ Rinse solution selected for contaminants
- ◆ Pressurized sprayers
- ◆ Curtains, enclosures or spray booths

Heavy equipment decon (Page 2)

- ◆ Long handled brushes, rods and shovels for dislodging contaminants
- ◆ Containers to hold contaminants and contaminated soil removed
- ◆ Wash and rinse buckets, brooms and brushes for use in decon inside vehicles
- ◆ Containers for storage and disposal of contaminated wash and rinse solutions

Personal protection during decon

- ◆ More protection for decon workers needed when deconning outside EZ
- ◆ In some cases, workers should wear same PPE as those being deconned
- ◆ May also be able to use one level lower
- ◆ Level of protection varies with type of equipment being deconned
- ◆ A qualified health and safety professional should determine decon PPE

Emergency decon

- ◆ Emergency decon procedures should be established
- ◆ The primary concern should be to prevent loss of life or severe injury, delay decon until victim stabilized
- ◆ If decon can be performed and not interfere with first aid measures, it should be conducted immediately
- ◆ Provisions should be made to protect medical personnel and disposing of contaminated clothing

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