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 70ºF (21ºC)
- 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 99.6ºF (37.6ºC), 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 100.6ºF (38.1ºC)

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

- 90ºF (32.2ºC) and above
  - Normal work ensemble
    - After each 45 minutes of work
  - Impermeable ensemble
    - After each 15 minutes of work
- 87.5-90ºF (30.8-32.2ºC)
  - Normal work ensemble
    - After each 60 minutes of work
  - Impermeable ensemble
    - After each 30 minutes of work

Recommended monitoring (Page 2)

- 82.5-87.5ºF (28.1-30.8ºC)
  - Normal work ensemble
    - After each 90 minutes of work
  - Impermeable ensemble
    - After each 60 minutes of work
- 77.5-82.5ºF (25.3-28.1ºC)
  - 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

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

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

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

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^{o}F
- Difficult to absolutely identify compounds
- High concentrations of contaminants or oxygen deficient atmospheres require system modifications
- Requires experience in interpreting data

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

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

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

First aid/CPR

- All employees covered under the HAZWOPER standard should have training in first aid and CPR
- I certify that within the past year I have had refresher first aid/CPR training
- If you respond “No”, you will not be able to take the certifying exam for this section until you have successfully completed the first aid/CPR course. However, you can proceed next lesson

No

Yes

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

Aliphatic 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, absbestosis, 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

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
Breathing difficulties
Changes in skin color
Coordination difficulties
Coughing
Dizziness
Drooling
Diarrhea
Fatigue
Irritability
Irritation of eyes, nose, skin
Headache
respiratory tract
Light-headedness
Nausea
Sneezing
Sweating
Tearing
Tightness in chest
Vomiting

Indications of heat stress

Clammy skin
Confusion
Dizziness
Fainting
Fatigue
Heat rash
Light-headedness
Nausea
Profuse sweating
Slurred speech
Weak pulse

Indications of heat stroke

Confusion
Convulsions
Hot skin
High temperature
Incoherent speech
Staggering gait
Sweating stops
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 lector 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

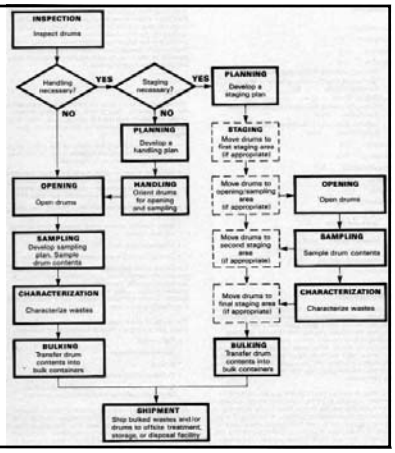
Lesson 11

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 grappler 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:

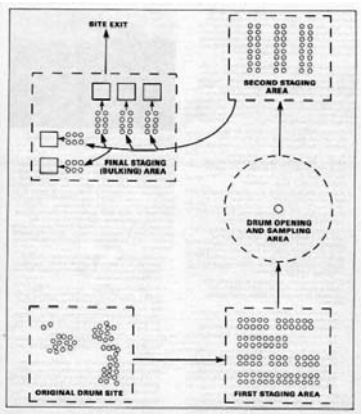
Auto-reactives	Pesticides
Water reactives	Cyanides
Inorganic acids	Inorganic oxidizers
Organic acids	Organic oxidizers
Heavy metals	

- Characterize using an onsite lab, if available

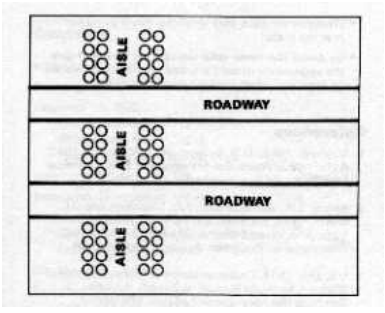
Drum staging

- 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

Prevention of contamination

- Establish standard operating procedures that minimize contact with waste
- Stress work practices that minimize contact wit 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 deconning
- 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

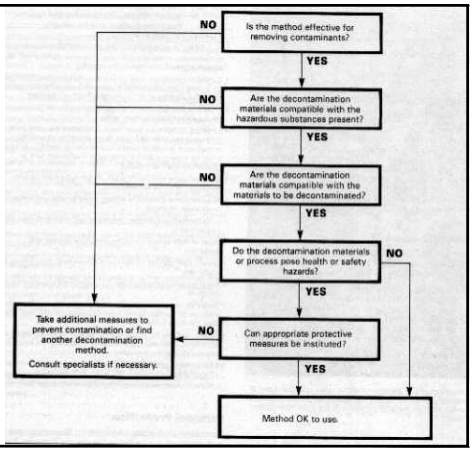
Testing decon effectiveness (Page 2)

- 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



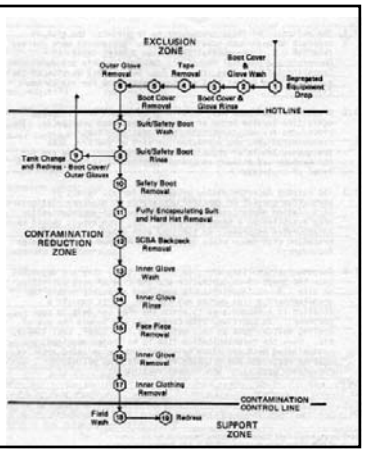
Decon facility design

- 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

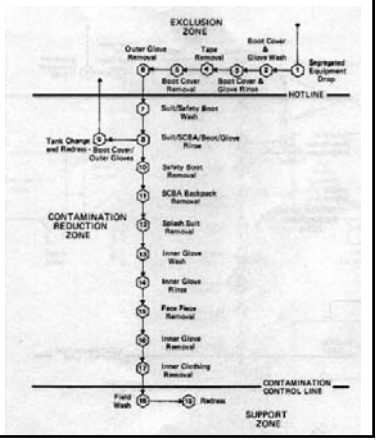
Design (Page 2)

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

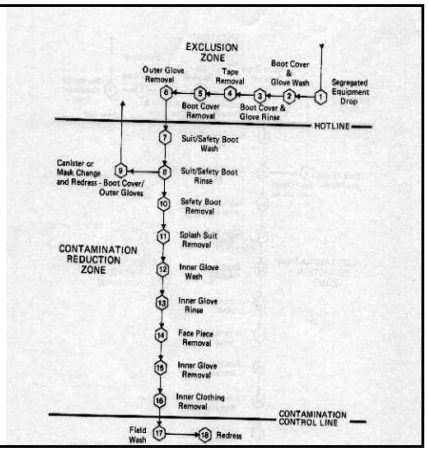
Level A Max decon



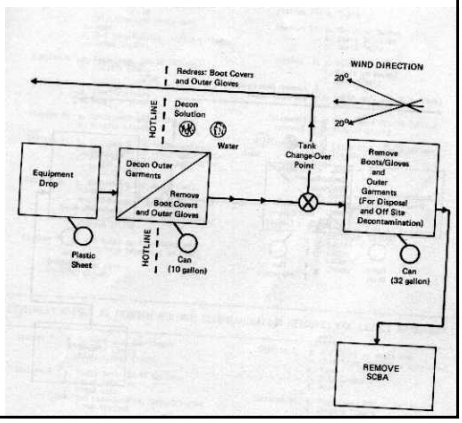
Level B max decon



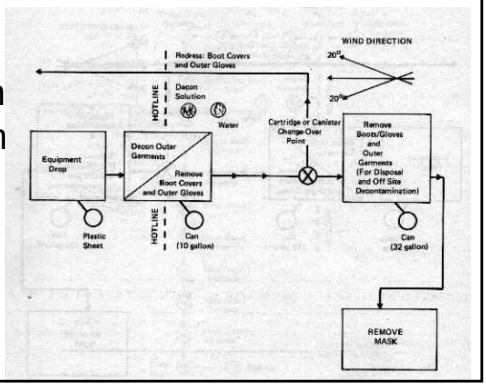
Level C max decon



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

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