TECHNICAL

PROCEDURAL GUIDANCE

# PERSONAL HEALTH AND SAFETY PROTECTION

**NOTES**

## Personal Health and Safety Protection

## GUIDANCE SUMMARY-AT-A-GLANCE

# BSPR policy is that **you are to avoid placing yourself in situations at an incident scene that represent a health and safety hazard.** Direct personal investigation or cleanup work by spill responders is authorized only in locations where level of protection D is appropriate.

# Site safety hazards that you become aware of should be communicated to other personnel who are on the site.

# State and federal law require all spill response employees to have the requisite health and safety training to perform their jobs safely. In addition, all spill response employees should participate in a medical monitoring program. NYSDEC provides initial 40-hour health and safety training and the 8-hour refresher and supervisory courses, as well as instruction on hazardous materials handling, Basic First Aid, and CPR. Baseline, yearly, and termination physicals for employees are also provided through NYSDEC.

# Basic health and safety guidelines to follow are: (1) **Begin thinking about specific health and safety concerns prior to arriving on the scene**, (2) **NYSDEC spill response personnel are not first responders**, (3) **Always be careful**, (4) **Stay upwind**, (5) **Employ the buddy system whenever possible**, (6) **When in doubt, get out**, (7) **Know your limitations**, (8) **Sometimes, no response may be the best response, provided that you and others are positioned at a safe distance from the incident scene**.

# Familiarize yourself with the EPA levels of personal protection and what types of health threats indicate the need for greater levels of personal protection. A summary of these personal protection levels is provided in this section. Make sure your personal protective equipment and monitoring devices are in good working order and calibrated properly (see Part 2, Section 2).

# Familiarize yourself with such terms as OSHA-PEL, TLV-TWA, and IDLH, which refer to exposures to air-borne contaminants; these are the health-based thresholds that, if exceeded, should trigger action to upgrade personal protection and/or to exit the site. See also Exhibit 2.1-5.

# Don't work in potentially explosive or oxygen-deficient atmospheres. Means to detect these conditions are discussed in this section and the next.

# Other physical hazards such as excessive heat or cold, noise, ionizing radiation, working near heavy equipment, electricity, holes and/or ditches, unstable surfaces, and working in or on water also demand your attention for personal health and safety protection. Biological hazards can also be a concern, especially if you have allergies.

# A number of relevant health and safety references are cited at the end of this section. You may want to have these in your personal or office reference library.

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## 2.1 Personal Health and Safety Protection

The Bureau of Spill Prevention and Response (BSPR) is committed to the protection of the health and safety of its spill response employees. All spill response personnel are to comply with all state and federal health and safety regulations applicable to responding to petroleum and hazardous substance releases. At the same time, as a spill responder, **you are to avoid placing yourself in situations at an incident scene that represent a health and safety hazard.** Direct personal investigation or cleanup work by spill responders is authorized only in locations where level of protection D is appropriate. Accordingly, our guidance focuses on enhancing your ability to recognize/detect potential hazards and to respond appropriately.

Your personal protection and that of others under your direction must take precedence over any other concern; that is, carry your emergency air pack (i.e., escape SCBA) and wear other protective clothing in situations that warrant it. While we recognize that a sensitivity to public perception is important, we do not condone foregoing the use of personal protective equipment designed to protect your health and safety.

NYSDEC provides several health and safety training courses, including the 40 hours of Safety and Operations at Hazardous Materials Sites; Basic First Aid and Cardiopulmonary Resuscitation (CPR); Hazardous Materials I & II; and an 8-hour health and safety refresher and supervisory course. Medical monitoring is also provided. Exhibit 2.1-1 is a summary of the requirements for health & safety training and medical monitoring.

This section discusses the state and federal regulations governing health and safety protection and provides guidelines and procedures for dealing with specific health and safety hazards at emergency response incidents. A generic health and safety plan has been provided as well as a description of an incident scene safety system. You will find additional information on specific health and safety hazards in Appendices O and P.

### 1. <u>Existing Federal and State Policy/Regulation</u>

New York State has an approved state plan under Section 18 of the Occupational Safety and Health Act of 1970 that addresses health and safety requirements for public employees. In addition, the Occupational Safety and Health Administration (OSHA) has developed health and safety regulations applicable to individuals in the public or private sector who are involved in the handling of hazardous materials or who may potentially come into contact with such materials. OSHA's regulations entitled "Hazardous Waste Operations and Emergency Response," therefore, apply to BSPR employees and contractors.

These regulations address requirements for employee health and safety training and medical monitoring, as well as for the preparation of health and safety plans to govern site activities. While these regulations are oriented predominantly to hazardous waste site operations, NYSDEC has elected to apply these requirements to the Spill Response Program.

**Exhibit 2.1-1**

**Health & Safety Training**
**& Medical Monitoring Requirements**

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HEALTH & SAFETY TRAINING

- 40 hours of initial health & safety training
- 8 hours of annual health & safety refresher training
- 8 hours of supervisory training for supervisors
- 24 hours of on-the-job training
- Red Cross First Aid (or its equivalent)
- CPR training

MEDICAL MONITORING

- A medical evaluation is required for employees to wear respirators.
- Baseline, periodical, and termination physicals are required for individuals who may be exposed to chemicals and for individuals who wear respirators more than 30 days per year.

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Accordingly, NYSDEC policy states that **when response activities are conducted where atmospheric contamination is known or suspected to exist, personal protective equipment must be worn to prevent or reduce skin and eye contact as well as inhalation or ingestion of a chemical substance.** Protective equipment requirements have been divided into four categories -- Levels A, B, C, and D, as stated in 29 CFR 1910.120. Level A personal protection requirements are the most stringent, while Level D are the least stringent. Exhibit 2.1-2 describes these four protection levels and the types of personal protective equipment required.

## 2. Health and Safety Training and Medical Monitoring Requirements

NYSDEC employees and their contractors who respond to petroleum and hazardous material (hazmat) incidents are to be provided with health and safety training as specified by OSHA. Your training should consist of an initial 40-hour health and safety training course that includes a discussion of toxicology, personal protective equipment, field monitoring instrumentation (see also Part 2, Section 2), site control, and hazard recognition. You must be "fit-tested" for the proper use of respirators as part of your 40-hour training course. A mandatory written test may also be part of the 40-hour course.

Hands-on training experience in the use of Level B and Level C personal protective equipment and in the use of field monitoring instruments is also necessary. During your first 24 hours of on-the-job training is also necessary following completion of your training course, your immediate supervisor must also write a letter to your health and safety file covering such information as the location, dates, tasks performed, and level of personal protection worn for each incident you responded to during that period.

An eight-hour annual health and safety training refresher course is also required by OSHA. This course emphasizes hands-on training with field monitoring instruments, and the use of personal protective equipment (PPE), which includes putting on and removing PPE. A written test will also likely be required. Supervisors of spill response personnel must receive an additional eight (8) hours of so-called "supervisory" health and safety training, as they will be directing the work of others at incident sites.

This eight (8) hours of supervisory training is not an annual requirement.

The OSHA regulations also require that medical surveillance be "provided to employees who have been or are expected to come in contact with hazardous substances or health hazards above established permissible exposure limits for 30 or more days in a 12 month period."[1] The purpose of medical monitoring is to have the capability to detect health impacts that may be the result of an exposure to a hazardous substance. Note that any individual who has potentially been exposed to hazardous substances is to be enrolled in a medical monitoring program whether or not he or she has worked

**Exhibit 2.1-2**

**Levels of Personal Protection**[a]

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**LEVEL A -** To be selected when the greatest level of skin, respiratory, and eye protection is required.

Level A equipment; used as appropriate

1. Pressure-demand, full-face-piece self-contained breathing apparatus (SCBA), or pressure-demand supplied air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH).

2. Totally-encapsulating chemical-protective suit.

3. Coveralls.[b]

4. Long underwear.[b]

5. Gloves, outer, chemical-resistant.

6. Gloves, inner, chemical-resistant.

7. Boots, chemical-resistant, steel toe and shank.

8. Hard hat (under suit).[b]

9. Disposable protective suit, gloves and boots (Depending on suit construction, may be worn over totally-encapsulating suit).

10. Two-way radios (worn inside encapsulating suit).

*Level A protection should be used when:*

# The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either the measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or the site operations and work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin;

# Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible; or

# Operations must be conducted in confined, poorly ventilated areas and the absence of conditions requiring Level A have not yet been determined.

**Exhibit 2.1-2**

**Levels of Personal Protection[a]**
**(continued)**

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**LEVEL B -** The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.

Level B equipment; used as appropriate.

1. Pressure-demand, full-face-piece self-contained breathing apparatus (SCBA), or pressure-demand supplied air respirator with escape SCBA (NIOSH approved).

2. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls).

3. Coveralls.[b]

4. Gloves, outer, chemical-resistant.

5. Gloves, inner, chemical resistant.

6. Boots, outer, chemical-resistant steel toe and shank.

7. Boot-covers, outer, chemical resistant (disposable).[b]

8. Hard hat.

9. Two-way radios (worn inside encapsulating suit).

10. Face shield.[b]

Level B protection should be used when:

# The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection;

(NOTE: This involves atmospheres with IDLH concentrations of specific substances that do not represent a severe skin hazard; or that do not meet the criteria for use of air-purifying respirators.)

# The atmosphere contains less than 19.5 percent oxygen; or

# The presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.

**Exhibit 2.1-2**

**Levels of Personal Protection[a]**
**(continued)**

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**LEVEL C -** The concentrations(s) and type(s) of airborne substance(s) are known and the criteria for using air purifying respirators are met.

Level C equipment; used as appropriate.

1. Full-face or half-mask, air purifying, canister equipped respirators (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.[b]
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical resistant.
6. Boots, (outer), chemical-resistant steel toe and shank.[b]
7. Boot-covers, outer, chemical resistant (disposable).[b]
8. Hard hat.
9. Escape mask.[b]
10. Two-way radios (worn under outside protective clothing).
11. Face shield.[b]

Level C protection should be used when:

# The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin;

# The types of air contaminants have been identified, concentrations measured, and a canister respirator is available that can remove the contaminants; and

# All criteria for the use of air-purifying respirators are met.

**Exhibit 2.1-2**

**Levels of Personal Protection[a]**
**(continued)**

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**LEVEL D -** A work uniform affording minimal protection: used for nuisance contamination only.

Level D equipment; used as appropriate

1. Coveralls.
2. Gloves.[b]
3. Boots/shoes, chemical-resistant steel toe and shank.
4. Boots, outer, chemical-resistant (disposable).[b]
5. Safety glasses or chemical splash goggles.[b]
6. Hard hat.
7. Escape mask.[b]
8. Face shield.[b]

Level D protection should be used when:

# The atmosphere contains no hazard; and

# Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

NOTE: As stated before, combinations of personal protection equipment other than those described for Levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection.

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[a] *This information is taken from 29 CFR 1910.120 Appendix B.*
[b] *Optional, as applicable.*

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for 30 or more days in situations necessitating the use of a respirator (i.e., the use of a respirator is an indicator of hazardous-substances-oriented work).

A medical surveillance program, as recommended by OSHA, is comprised of three physicals: baseline, annual, and termination. The baseline physical establishes your physical condition prior to beginning work where exposure to hazardous substances is a possibility. The physician must also certify that you are physically capable of wearing respiratory equipment. The annual physical is used to check your condition relative to your baseline for as long as you respond to petroleum and hazmat incidents, so that significant changes can be recognized and possibly remedied. The termination physical is administered when you leave the Spill Response Program in order to document your condition at the conclusion of your spill response duties. OSHA also requires that medical examinations by physicians be given whenever employees develop signs or symptoms of chemical exposure. All these medical surveillance records must be kept for a period of 30 years. Baseline, annual, and termination physicals are provided by DEC for spill response personnel.

A recommended medical monitoring program is outlined in the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, 1985 (p. 5-2). Medical monitoring methods for certain chemicals are also covered in this manual. OSHA has not specified that certain tests must be conducted as part of a medical monitoring program.

## 3. Health and Safety Hazard Guidelines

Follow these health and safety hazard guidelines in the conduct of an incident response. You may add your own guidelines to this list.

- # Do your homework before arriving on the scene. If you know what has been released, look up the safe airborne chemical contaminant exposure levels, the signs and symptoms of exposure, physical and chemical data, and first aid information for all the chemicals of concern. Make note of the police, fire, ambulance, and hospital phone numbers for the local area surrounding the incident site. Much of this information should already be in the Regional Contingency Plan. Develop a checklist of the items to bring on-site and make sure this equipment is in good condition. Determine current and expected weather conditions at the incident scene. Weather conditions often determine what personal protective equipment you wear and may be particularly important in making decisions about evacuating residents, positioning the command post, and several other incident response actions.

- # DEC spill response personnel are not first responders. Although you may be the first to arrive at the spill scene, remember that BSPR personnel are not first responders. It is program policy that other, usually better trained and better equipped personnel, such as local fire departments, hazardous material teams, or contractors (hired by the state or the spiller), are the preferred first responders. Your role is to consult with these personnel about the appropriate response. We recognize, however, that you may be the first to arrive and confront an emergency situation demanding prompt action. In these limited situations, you may take and/or authorize actions to deal with the emergency (for more on this policy, see Part 1, Section 3, Emergency Response).

# Always be careful. Pay attention and remain alert to changes in site or weather conditions. Such changes may require upgrading your level of protection or even exiting the area. Monitor your work area. This includes not only monitoring the air, but watching out for heavy equipment and vehicular traffic as well. Watch where you step and what you step in or on to. Wear a life jacket when positioned on or near waterways.

# Stay upwind. Avoid placing yourself in a situation where exposure to a hazardous substance is possible, especially if you are not equipped with proper personal protective gear. Stay upwind of the incident scene and remain cognizant of changes in wind direction that might suddenly place you in danger.

# Employ the buddy system. Although it will not always be possible for you to do so, make an effort to be accompanied by at least one other spill responder (local, state, or contractor personnel) while engaged in response activities. Unexpected events do occur at an incident site that may hamper your ability to react to the hazard; a second individual may have to come to your aid. A second spill responder may also have information sources or a different viewpoint that can prove useful, especially in an emergency response situation.

# When in doubt, get out. If you are ever uncertain about the nature of the possible safety and health hazards and whether you are protected adequately, it's best to withdraw from the site into a safe area. Take the time to reevaluate the situation before proceeding.

# Know your limitations. Be aware of your physical, mental, and emotional condition and limitations. Failure to pay attention to problems such as fatigue or illness may endanger your life and possibly lead to poor decision-making that endangers the life and safety of others.

# Sometimes, no response may be the best response. Often, you may feel that you must take some sort of action at an incident site. This is not always true, however, and, in some cases, taking no action may be the better approach to protect human health and the environment. Letting a fire burn to consume the spilled product, for example, may be better than having the fire department extinguish the fire. The action you take can also result in unanticipated effects of greater impact to the public health and/or the environment than the original situation. Always consider the possibility that no

response may be the best response at the incident scene, provided that you and others are positioned at a safe distance.

You will find additional safety guidelines for your work in Safety Guidelines for DEC Division of Water Personnel (November 1982). This document addresses safety at spills and fires, as well as general field safety, vehicle safety, general sampling safety, and safety during plant and dam inspections.

## 4. If You Are Injured or Exposed to Chemicals

If you ever suffer an injury or are exposed to a hazardous chemical while responding to an incident, summon help or get yourself to someone who can provide medical attention immediately. This is why we encourage use of the buddy system; you may not be able to help yourself in these situations. It is also why we emphasize planning for your own protection by using the incident scene safety system and/or the generic health and safety plan. If you know where the nearest hospital is and how to get there, or the emergency services telephone numbers, the better your chances are of receiving prompt medical attention when it's needed. Your standard equipment inventory also includes a first-aid kit (keep it stocked) and, perhaps, an eye wash bottle.

Work-related injuries and chemical exposures need to be reported to your supervisor and to the designated office or site safety officer. This will start a process to investigate the cause(s) of the incident and to fulfill the reporting and other requirements of the state and federal occupational health and safety regulations.

## 5. Health and Safety Planning

During an emergency incident involving petroleum or a hazardous material, rarely, if ever, will it be practical to write up an incident-specific site safety plan as recommended in state and federal regulations. Response time limitations dictated by the size, type, intensity, and severity of the emergency will make impromptu writing of a site safety plan impractical. Site safety plans that are called for in federal and state regulations are applicable, for all practical purposes, to hazardous waste site or UST clean-up activities where there are no immediate health threats to the public and, therefore, sufficient time to prepare thorough written site safety plans prior to initiating site activities. Facility- or building-specific site safety plans that were prepared prior to the emergency incident, however, should prove useful during an actual emergency. In such cases, emergency responders should implement the plan in a coordinated effort with the facility/organization that prepared the plan. A generic site safety and health plan has been included in Appendix O, should BSPR personnel wish to develop any pre-incident site safety plans for specific facilities.

For transportation accidents and for incidents involving facilities/buildings that do not possess pre-written site safety plans, emergency responders must have a standard operating procedure (SOP) for establishing an incident scene safety system. This safety system must be sufficiently generic and flexible to be

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applied to any incident while, at the same time, sufficiently comprehensive to cover all necessary safety precautions. An incident scene safety system of this type does not have to be written for each specific incident as is the case with a site safety plan. The system, established through a SOP, can be easily and quickly implemented at any emergency incident, provided that the emergency responders are familiar with the system and have practiced using it.

The SOP for establishing an incident scene safety system should address the following operations and topics:

- Establishment of hazard (or safety) control zones;
- Positioning of personnel, apparatus, and equipment;
- Selection and use of personal protective gear;
- Safe operating practices;
- Medical monitoring and emergency medical care;
- Decontamination of response personnel, protective gear, and equipment.

The responsibility of establishing and managing the incident scene safety system should be given to a fire department or emergency medical services (EMS) officer, as they normally have the knowledge and skills required for the task. The individual in charge of the safety system (i.e., Safety officer) may also have a team of appointed assistants. BSPR personnel are not likely to be involved in establishing and managing the incident scene safety system, but will be expected to operate within the system, as will all on-scene emergency responders. BSPR personnel should talk to the Safety Officer to obtain incident-specific safety procedures. If an incident scene safety system has not been established by first-responders, BSPR personnel should call this to the attention of the Incident Commander and, if necessary, assist in establishing the system.

a. Hazard Control Zones

One component of the safety system is establishing hazard (or safety) control zones at the incident scene. The zones are established to protect response personnel by limiting the number of people in the most hazardous areas. The exact size and configuration of these hazard control zones will be determined at each particular incident, as they must be based upon incident-specific factors and situations (e.g., chemical and physical hazards, atmospheric conditions, topography, etc.). The Safety Officer must establish these zones and visually designate their locations. Visual observations and air monitoring data will help in determining the boundaries of the zones, which should be designated by barrier tape, barricades, traffic cones, rope, and the like. The standard hazard control zones include the following:

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- # "Hot Zone" - Area of maximum hazard surrounding the damaged containers or fire area; only entry team allowed within.

- # "Warm Zone" - Area of moderate hazard, beyond the Hot Zone, where backup crews stand by and decontamination takes place.

- # "Cold Zone" - Area beyond the Warm Zone that poses minimal or no hazards to emergency responders. The command post, most or all of the deployed apparatus, and the resource staging area are located in the Cold Zone.

During the incident, safety control zones should be adjusted as necessary to compensate for changing incident scene conditions.

b. Positioning of Personnel and Resources

Based upon the hazard control zones, the Safety Officer must advise the Incident Commander of the safest locations in which to deploy personnel and resources. An absolute minimum number of personnel, apparatus, and equipment should be deployed in the "Hot" and "Warm" zones in order to limit exposures to contaminants. Apparatus and major pieces of equipment should be positioned in such a manner that allows for emergency escape routes, as well.

c. Personal Protective Equipment

Selection and use of personal protective equipment (PPE) is another component of the incident scene safety system. The Safety Officer must determine the types of PPE needed for each of the three hazard control zones, with particular emphasis on PPE required in the "Hot" and "Warm" Zones. BSPR personnel should only be operating within the "Cold Zone." Check with the Safety Officer as to what type of PPE is needed in that zone. It is likely that the standard-issue PPE provided to BSPR personnel will be adequate for their incident scene response activities. If not, BSPR personnel will have to make arrangements to secure the use of appropriate PPE or withdraw from the area entirely.

Selecting appropriate PPE and using it properly is not an easy task. One must match the PPE to the chemical(s) involved, atmospheric conditions, physical hazards presented, and the physical condition of the user.

The attachments at the end of this section contain several helpful references that should be consulted for selecting and using PPE. The references were extracted from several excellent documents published by the U.S. Environmental Protection Agency (EPA), National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), and U.S. Coast Guard (USCG). The appendix contains several tables, matrices, listings, and narratives presenting information on the following topics:

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- # Attachment 2.1-1 - Types of PPE and accessories (by body part protected; i.e., full body, head, eyes and face, ears, hand and arms, feet, etc.);

- # Attachment 2.1-2 - Sample protective ensembles (including protection provided, when to use, and limiting criteria);

- # Attachment 2.1-3 - Advantages and disadvantages of the various categories of respiratory protective equipment (i.e., SCBA, supplied-air respirator, air-purifying respirator);

- # Attachment 2.1-4 - Types of self-contained breathing apparatus (including advantages and disadvantages);

- # Attachment 2.1-5 - Selecting chemical protective clothing;

- # Attachment 2.1-6 - Selecting the level of protection based upon atmospheric vapor/gas concentrations;

- # Attachment 2.1-7 - Protective materials (including advantages and disadvantages);

- # Attachment 2.1-8 - Compatibility between suit materials and chemicals;

- # Attachment 2.1-9 - Physical characteristics of chemical protective clothing; and

- # Attachment 2.1-10 - Sample donning and doffing procedures.

d. Safe Operating Practices

Safe operating procedures should also be covered in the incident scene safety system and enforced by the Safety Officer. These procedures should address the following topics at a minimum:

- # Establishing hazard (or safety) control zones (see above);

- # The use of appropriate protective gear and equipment (see above);

- # Limiting the number of personnel in the "Hot" and "Warm" hazard control zones;

- # Establishing a "buddy system" for all personnel operating within contaminated areas;

- # Avoiding contact with all contaminants and contaminated surfaces whenever possible;

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- # Advising all response personnel of site control and safety policies;
- # Staying upwind and upgrade of released chemicals;
- # Designating an entry team support crew to assist in dressing the entry team, keeping track of air supply time requirements of the entry team, and keeping track of the exposure time of the entry team;
- # Utilizing the most experienced personnel for the most hazardous tasks;
- # Establishing hand/arm signals as a backup communication system between responders working in encapsulated suits, and establishing an emergency signal (e.g., continuous airhorn blast) for emergency withdrawal;
- # Positioning a backup team in the "Warm Zone" in case they need to rescue personnel from the "Hot Zone";
- # Providing medical monitoring for personnel before and after "Hot" and "Warm" Zone operations (see below);
- # Monitoring (visually and through communications contact) the welfare of personnel operating with the "Hot" and "Warm" zones;
- # Ensuring that all personnel understand and know how to perform their assignments prior to initiating them;
- # Ensuring that responders do not accidentally ingest contaminants through eating, drinking, or smoking;
- # Enforcing a "No Smoking" policy at incidents involving flammable or combustible materials;
- # Decontamination of protective gear and response equipment (see below);
- # Replacing fatigued personnel with "fresh" personnel;
- # Adjusting the hazard control zones to reflect changing conditions;
- # Halting any unsafe operation;
- # Establishing a rest and rehabilitation area that offers protection from the elements and has toilet facilities.

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Additional safety practices can be found in Attachment 2.1-11 at the end of this section. For further information concerning safe operating procedures and site safety, refer to the following publications and documents:

- # Field Standard Operating Procedures (FSOP) #9 - Site Safety Plan. Environmental Protection Agency, April 1985.
- # Standard Operating Safety Guides. Environmental Protection Agency, July 1988.
- # Hazardous Materials Incident Responde Operations, Environmental Protection Agency, August 1988.
- # Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/ USCG/EPA, October 1985.
- # Hazardous Materials: Managing the Incident, Noll, Hildebrand, and Yvorra, Fire Protection Publications, Oklahoma State University, Stillwater, Oklahoma, 1988.
- # Safety Guidelines for DEC Division of Water Personnel, November 1982.

e. Medical Monitoring and Emergency Medical Care

Medical monitoring and care is another component of an incident scene safety system. The Safety Officer must ensure that there are qualified medical personnel on hand to check and, if necessary, treat sick, injured, or contaminated response personnel. Medical personnel must also be present to check the vital signs (i.e., blood pressure, pulse, and respiration rate), weight, body temperature, and general health of all personnel before and after they enter the "Hot" or "Warm" Zones. The Safety Officer must also ensure that there are sufficient emergency medical units (i.e., Advanced Life Support and Basic Life Support ambulances) and equipment (i.e., bandages, oxygen, IV fluids, drugs, etc.) on-scene to handle medical monitoring and care operations. The Safety Officer will need to coordinate medical monitoring and care with the EMS Officer or other senior-level EMS representative.

Medical monitoring is very important for all emergency responders at an incident. Whereas the entry and backup teams are monitored before and after entering hazardous areas, all responders who may have been exposed to contaminants must be medically monitored afterwards. If signs or symptoms of chemical exposure or other medical problems are noted, the victim should be treated at the incident scene, when appropriate, and transported to a hospital for evaluation by a physician. Persons who do not show immediate signs or symptoms of illness or distress should be examined by a physician, anyway, as a precaution. The signs and symptoms of some chemicals (e.g., certain pesticides) may not appear for several hours or days. Prior to leaving an incident scene, personnel should be briefed by the Safety Officer or EMS Officer on the signs and symptoms of exposure to the involved chemical(s) so that they can seek immediate medical treatment when required.

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BSPR personnel should rarely be exposed to contaminants due to their limited involvement in emergency response activities; however, any BSPR personnel who were exposed, or think they may have been exposed, to chemicals should be monitored by on-scene EMS personnel and evaluated by a physician. Any comprehensive medical examination that is necessary should be conducted by a physician who has access to your baseline medical profile as well as records regarding your annual physicals and any other medical examinations.

Emergency medical care that becomes necessary due to injury or illness contracted at the incident scene must be administered as soon as possible. Patient contamination or the possibility of contamination will complicate treatment efforts considerably. When treating contaminated individuals, medical personnel must consider the following precautions and procedures:

# Medical personnel will need to wear specialized protective gear to protect themselves from contaminants on their patient(s).

# EMS personnel will need to take steps to protect their equipment and the ambulances from contamination.

# The patient(s) will have to be decontaminated as much as is practicable prior to treatment and transport to the hospital.

# Special protocols may be required in order to treat chemically-exposed patients, including the administering of chemical antidotes and drugs.

# Patients will have to be transported to hospitals that have proper decontamination facilities, equipment, and procedures (except in cases where life-threatening problems, such as cardiac arrest, breathing difficulties, etc., are involved).

# Ambulances, equipment, and EMS personnel will require decontamination prior to treating/ transporting other patients.

Whenever emergency responders are monitored or treated for chemical exposure, records must be kept and made available to the patient and to treating physicians upon request. Medical records and exposure logs must be complete and accurate in order to be useful during subsequent review.

f. Decontamination

Another component of the incident scene safety system is decontamination of response personnel, protective gear, and response equipment. Decontamination is performed for the purposes of protecting the health of emergency personnel, preventing the spread of contamination, and salvaging personal protective equipment (PPE) and other response equipment to permit reuse, when feasible.

Decontamination (decon) operations can be quite elaborate such as those recommended by EPA, NIOSH, and OSHA for hazardous waste site activities, where circumstances allow for a more comprehensive approach (i.e., sufficient time to plan decon operations and to obtain appropriate decon resources and sufficient personnel are available at the site, etc.). For example, for decon of Level-A PPE, EPA recommends a 19-step procedure that involves the establishment and operation of 19 separate decon "stations" (in an assembly line fashion) which require a significant number of personnel and resources to operate effectively.[2] Rarely would there be this quantity of trained personnel and decon resources available at an emergency incident to allow a decon operation of this magnitude to take place on a timely basis. For this reason, a more practical approach to emergency scene decon is presented below, which takes into account the need to set up the decon area quickly with limited on-scene resources. The recommended approach is the "Nine Step Decon Procedure" presented in the publication Hazardous Materials: Managing the Incident, written by and for hazardous materials emergency responders.

BSPR personnel have three main responsibilities regarding decontamination: (1) to ensure that they themselves undergo decon when necessary, (2) to ensure that all exposed emergency responders are properly decontaminated, and (3) to ensure that decon operations are conducted in a manner that minimizes environmental contamination. BSPR personnel should assist the Decon officer (probably an EMS or fire department officer appointed by the Incident Commander) in establishing and overseeing decon operations and should coordinate the decon of exposed BSPR personnel with the Decon Officer. The decon operation itself should be performed by a team of trained personnel (i.e., the Decon Team) composed of on-scene responders from the local EMS organization, fire department, health department, etc., under the supervision of the Decon Officer and Safety Officer.

The Decon Officer's first task is to determine where decon will take place. That decision will depend upon the following factors:

- Weather conditions (i.e,. temperature, precipitation, wind);
- Incident scene topography and physical characteristics;
- Presence of environmentally sensitive areas (e.g., waterways, ponds);
- Chemical and physical hazardous present;
- Availability of decon resources.

**NOTES**

Ideally, the decon area should be upwind and uphill of the involved containers and chemical(s) and remote from storm drains, manholes, waterways, bodies of water, etc. The above factors, however, may necessitate the establishment of a decon area in a less than ideal setting. Adverse weather or the unavailability of adequate resources may even necessitate the establishment of an off-scene decon site such as a fire station, school, or hospital. Off-scene decon, however, will be more complicated due to the following reasons:

- # The need to transport contaminated personnel and equipment to the off-site location;
- # The need to decontaminate the transport vehicles;
- # The need to confine or treat contaminated decon runoff if a holding tank is not in place at the facility.

After choosing a safe and practical decon site, the Decon Officer must obtain technical guidance on the proper method of decon for the specific chemical(s) involved. Sources of technical information include chemical manufacturers, computer databases, technical assistance hotlines, books, PPE manufacturers, toxicologists, chemists, etc. Information on contacting these sources should be contained in emergency response plans of state and local agencies. Technical guidance that must be obtained includes methods of decon (for humans and equipment), special detergents and neutralizers required, safety precautions, disposal information, etc.

Based upon the technical guidance obtained, the Decon Officer, in conjunction with the Safety Officer, must evaluate the health and safety aspects of the recommended decon method(s) and select the safest, most effective, and most practical method to attempt. Exhibit 2.1-3 should be used as a tool in making this decision.

After determining the manner in which decon will be accomplished, the Decon officer must obtain the equipment, materials, solutions, and supplies needed to conduct a safe and effective decon operation. Due to time limitations, the Decon Officer and Team may have to perform a preliminary decon of personnel with available resources (making sure that decon solutions are compatible with the chemical contaminants) and follow up with a more thorough decon when more appropriate resources arise. Exhibit 2.1-4 provides a sample listing of resources that may be required for decon operations. In addition, commonly used decon agents include water (for dilution and rinsing), household detergents, isopropyl alcohol, sodium hypochlorite (household bleach), sodium hydroxide, sodium carbonate slurry (washing soda), and calcium oxide (lime) slurry.[3] Emergency response units may already carry some of these products for decon purposes, and if not, these products can normally be obtained from nearby stores, industrial sites, or other sources.

**NOTES**

When decon resources have been assembled at the decon site, the Decon Team can set up the decon area in accordance with the layout determined by the Decon Officer. If the decon area is at the incident scene and established within the "Warm Zone," the Decon Team must wear appropriate PPE during both set-up and operation of the decon area. The level of protection worn by the Decon Team is determined by:

- # Expected or visible contamination on workers;
- # Type of contaminant and associated respiratory and skin hazards;
- # Total vapor/gas concentrations in the "Warm Zone";
- # Particulates and specific inorganic or organic vapors in the "Warm Zone"; and
- # Results of swipe tests .

**Exhibit 2.1-3**

**Exhibit 2.1-4**

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

**NOTES**

In situations where Decon personnel may be contaminated with unknowns, highly volatile liquids, or highly toxic materials, decontamination workers should wear Level B protection (see Attachment 2.1-2 at the end of this section). Otherwise, Level C protection should be worn.[4]

The decon area should be set up in an "assembly line" manner whereby contaminated personnel and equipment enter at the "dirty" end (entry point), proceed through a series of "stations" where various decon procedures occur, and exit into a "clean" area. Along the decon "assembly line," there should be a dirty (contaminated) side and a clean side established. The dirty side should have trash cans or drums for holding contaminated PPE or equipment that will require decontamination disposal. The clean side should be reserved for placing PPE and equipment that has been thoroughly decontaminated. Down the middle of the decon area, the Decon Team should set up the wash tubs, equipment, brushes, rags, decon solutions, shower facilities, etc., that will be used to decontaminate the contaminated response personnel. Upon setting up the decon area, the Decon team should refill their SCBA (if applicable) and take their assigned positions at the various decon stations.

As mentioned earlier, the "Nine Step Decon Procedure" is recommended for decontamination of emergency responders.[5] The steps are briefly described below:

- # Step 1 - Guide the contaminated personnel into the decon area through the designated entry point. Have them drop off any hand carried tools, monitors, or other equipment on the "dirty" side of the decon area.

- # Step 2 - Remove as much solid or liquid contaminants as possible from the PPE of the contaminated person by means of low-pressure water from a shower or hoseline. Dike the runoff or divert it to a retention basin or holding tank for later treatment and/or disposal.

- # Step 3 - Remove SCBA and place it in the "dirty" area for later decontamination.

- # Step 4 - Remove protective clothing and place it in the "dirty" area for later decontamination or disposal. Put clothing in a drum, trash can, or plastic bag in order to limit the spread of contaminants.

- # Step 5 - Remove street clothes, underclothing, and any personal items (jewelry, wallet, etc.) and place them in the "dirty" area. Put the clothing and items into plastic bags, label them with the owner's name, and provide security for them.

**NOTES**

- # Step 6 - Have the person thoroughly wash themselves under a shower, with liberal quantities of soap applied with a sponge. Ensure that the individual takes special care to wash his/her head, ears, groin area, and finger and toe nails, where contaminants can become lodged. Dike the runoff or divert it to a retention basin or holding tank.

- # Step 7 - Have the now-clean person dry off and dress in supplied coveralls or hospital gown. Put the towel(s) in a plastic bag and place the bag in the "dirty area."

- # Step 8 - Send the decontaminated person to a remotely located emergency medical station where paramedics or other qualified medical personnel can evaluate the person. If necessary, the person will be treated on-scene and/or transported to a hospital for treatment.

- # Step 9 - If the person is found to be medically fit, send him/her to a rest and rehabilitation area and observe their well-being while they rest. Complete and verify records regarding the individual's decontamination and medical evaluation. If at any time the person shows signs or symptoms of chemical exposure, have them evaluated again by on-scene medical personnel and transport them to a hospital.

Steps 5 through 7 should be performed inside a tent, decon trailer, or building in order to protect the person from the elements as well as from on-lookers. In addition, showering should be done with warm water.

If at any time during the decon process the contaminated person is suffering significant medical distress, the person should be removed from the decon area and treated immediately by qualified medical personnel. Unless it is a life-threatening situation, the patient should be decontaminated as much as is practicable prior to treatment.

After people have been decontaminated, the Decon Team should attempt to decontaminate PPE, tools, and equipment as much as possible. Items that absorbed chemicals will have to be disposed of or sent to private contractors for proper decontamination. Protective clothing should be decontaminated in accordance with the manufacturer's recommendations. Respiratory protective equipment and monitoring/sampling devices will probably have to be sent to the manufacturer or a qualified servicing center for decontamination and/or repair. Brooms, shovels, and similar tools will very likely need to be disposed of. The Decon Team may find it necessary or beneficial to transport containerized or bagged equipment to an off-scene facility in order to perform more effective decontamination. If so, proper procedures must be followed in order to ensure the safety of personnel and to prevent the spread of contaminants. Following equipment decon, the items should undergo a swipe test to determine whether equipment is completely clean. The cloth or paper patches used in the swipe tests must be analyzed at a qualified laboratory. Equipment should not be reused unless it is free of external and internal contaminants.

Following the decon process, the Decon Team must clean and disassemble the decon area, dispose of wastes, and return the site to its normal state. More specifically, the Decon Team, under the direction of the Decon Officer, health department, and DEC, must do the following:

- Decontaminate all of the decon equipment that is salvageable, so it can be reused;
- Place all waste materials in drums;
- Decontaminate all members of the Decon Team;
- Make arrangements for removal and disposal of confined wastewater and other wastes;
- Disassemble the decon area and coordinate the return of any borrowed resources.

## 6. Dealing with Specific Health and Safety Hazards

Each petroleum or hazmat spill incident will present a unique set of potential health and safety hazards. There is, therefore, no one set of hazards that you will encounter consistently, and no one set of preventative/remedial measures that can be recommended. We have outlined below, however, issues pertinent to some of the more common health and safety hazards.

### a. Chemical Exposures

Preventing or minimizing your exposure to toxic chemicals is your primary concern. There are four major ways in which a chemical can gain entry into your body: through inhalation, ingestion, dermal (skin) and eye absorption, and injection (puncture wound).

For most spill/leak incidents, your most significant concern will be exposure via inhalation. Assess the threat to yourself by comparing the ambient air concentrations you or others measure at a site with the different chemical exposure thresholds established by OSHA. If these levels are exceeded, keep all persons lacking appropriate protective gear from the hazardous area.

Familiarize yourself with the special terminology used to describe the various exposure thresholds.

- An OSHA permissible exposure limit (PEL) is an 8-hour time-weighted average (TWA) concentration. The OSHA-

PEL for a chemical is a legally enforceable workplace standard.

# The Threshold Limit Value-Time Weighted Average (TLV-TWA) is "the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect."[6] The TLV-TWA is developed by the American Conference of Governmental and Industrial Hygienists (ACGIH).

# The Immediately Dangerous to Life or Health (IDLH) level is defined as the level at which "one could escape within 30 minutes without experiencing any escape-impairing or irreversible health effects."[7] The IDLH levels are developed by the National Institute for Occupational Safety and Health (NIOSH). A spill responder should avoid being exposed at the IDLH level for any length of time without appropriate respiratory and dermal protection.

Determine the OSHA-PEL, TLV-TWA and IDLH levels for the substances known to be involved before placing yourself in a situation where an airborne exposure is possible. Knowing these levels for the substances of concern allows you to make the appropriate decisions regarding respiratory protection for yourself and others. Exhibit 2.1-5 provides you with some of these OSHA levels for several chemicals encountered frequently. Another more complete source of this information is the NIOSH Pocket Guide to Chemical Hazards; we recommend that you obtain a copy and bring it with you when you respond to incidents.

Potential chemical exposure through the skin and/or eyes may also be a significant concern. Wearing personal protective clothing and splash goggles can minimize the possibility of a chemical exposure to the skin or eyes.[1] If a chemical comes in contact with the skin or the eyes, be sure to flush skin or eyes with water for at least 15 minutes and seek medical attention.

In general, the ingestion or accidental injection of a hazardous substance during your spill response activities is not common, but exposure by these means is possible. Be aware, however, that smoking, eating, drinking, and gum chewing in the contaminated areas can increase your potential for ingesting hazardous substances. Wearing safety shoes, avoiding physical

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[1] *There are numerous guides available to assist you with the choice of an approved material to prevent skin exposure to a chemical. Some of these guides are listed at the end of this section.*

***Exhibit 2.1-5***

***OSHA-PEL and IDLH Levels for Chemicals of Concern in Spill Response Work*** [a]

| ***Chemical*** | ***OSHA-PEL*** [b,c] | ***IDLH*** [b,d] |
|---|---|---|
| *Acetic acid* | *10 ppm* | *1,000 ppm* |
| *Acetone* | *1,000 ppm* | *20,000 ppm* |
| *Ammonia* | *50 ppm* | *500 ppm* |
| *Benzene* | *1 ppm* | *2,000 ppm* |
| *Carbon dioxide* | *5,000 ppm* | *50,000 ppm* |
| *Carbon monoxide* | *50 ppm* | *500 ppm* |
| *Carbon tetrachloride* | *10 ppm* | *300 ppm* |
| *Chlorine* | *1 ppm* | *25 ppm* |
| *Ethyl acetate* | *400 ppm* | *10,000 ppm* |
| *Ethyl benzene* | *100 ppm* | *2,000 ppm* |
| *Hydrochloric acid* | *5 ppm* | *100 ppm* |
| *Hydrogen cyanide* | *10 ppm* | *50 ppm* |
| *Hydrogen sulfide* | *20 ppm* | *300 ppm* |
| *Isopropanol* | *400 ppm* | *20,000 ppm* |
| *Liquified petroleum gas* | *1,000 ppm* | *19,000 ppm* |
| *Methyl ethyl ketone* | *200 ppm* | *3,000 ppm* |
| *Methyl isocyanate* | *0.02 ppm* | *20 ppm* |
| *Nitric acid* | *2 ppm* | *100 ppm* |
| *Nitrogen dioxide* | *5 ppm* | *50 ppm* |
| *Phenol* | *5 ppm* | *100 ppm* |
| *Phosgene* | *0.1 ppm* | *2 ppm* |
| *Styrene* | *100 ppm* | *5,000 ppm* |
| *Sulfuric acid* | *0.54 ppm* | *4.32 ppm* |
| *Sulfur dioxide* | *5 ppm* | *100 ppm* |
| *Toluene diisocyanate* | *0.02 ppm* | *10 ppm* |

[a] *The chemicals listed in this table were chosen for inclusion because they are extremely toxic, are frequently found at incident scenes, and/or are constituents of a commonly encountered petroleum product.*

[b] *Field detection method is detector tubes unless otherwise noted.*

[c] *An OSHA permissible exposure limit (PEL) is an 8-hour time-weighted average (TWA) concentration. The OSHA-PEL for a chemical is a legally enforceable workplace standard.*

[d] *The Immediately Dangerous Life or Health (IDLH) level is defined as the concentration at which one could escape within 30 minutes without experiencing any escape-impairing or irreversible health effects.*

hazards, and using your common sense will help minimize the possibility of accidental exposure via a puncture wound.

b. Explosive Conditions

As discussed further in the section on Equipment, Training, Calibration, and Maintenance, use an explosimeter routinely at incidents to determine if explosive atmospheres and flammable vapors are present. Explosimeter readings are meaningful only if there is approximately 21 percent oxygen present (i.e., lower readings would be indicative of an oxygen-deficient atmosphere, see Subsection c. below). **Do not** depend on your explosimeter readings if the oxygen level is less than 19.5 percent or greater than 21 percent.

A reading of 10 percent of the lower explosive limit (LEL) serves to trigger continued monitoring; proceed cautiously with all further work (see below). At 25 percent of the LEL, all work should cease and you (and others) should immediately evacuate the area. Measures should then be taken, if possible, to reduce the vapor concentrations (see Part 1, Section 6.3, Vapors in Structures, Sewers, and Underground Utility Lines).

Take these measures to minimize the possibility of an explosion or a fire:

- Use non-sparking, explosion-proof instruments when first monitoring an unknown spill/leak situation.
- Keep all potential ignition sources away from an explosive or flammable environment.
- Use chemical compatibility tables whenever placing different chemicals in close proximity, so as to avoid a chemical reaction that could lead to an explosion and/or fire.

You may also be concerned with the ignitability of petroleum-contaminated soils. There are really two issues: (a) whether the soil qualifies as a hazardous waste, and (b) whether these soils need special handling to control the safety hazards associated with the volatile organic emissions coming off such soils.

EPA, in its preamble to the final federal UST technical standards rule, says the following concerning whether petroleum-saturated soils are a characteristic hazardous waste:

> *Although some states require the use of the EPA tests (for ignitability and EP toxicity), petroleum-contaminated soils do not satisfy the EPA criteria for an ignitable hazardous waste.*

> *A substance is classifiable as a hazardous waste if it exhibits the characteristic of ignitability according to one of the following four criteria. . . (1) a liquid containing less than or equal to 24 percent alcohol having a flashpoint less than 140 degrees F; (2) a nonliquid, but capable under standard temperature and pressure of causing fire through friction, absorption of moisture, or spontaneous chemical changes which burns so vigorously and persistently that it creates a hazard; (3) an ignitable compressed gas. . . or (4) an oxidizer. . . . Gasoline-contaminated soils do not satisfy criteria (1), (3), or (4). They do satisfy the nonliquid requirement of criterion (2); however, the Agency has concluded that they are very unlikely to be ever capable of causing fire by friction, absorption of moisture, or spontaneous chemical changes. These soils, therefore, should not be a hazardous waste under Subtitle C of RCRA due to ignitability.*

EPA goes on to say, however, that:

> There are potential threats that need to be considered in the management of petroleum-contaminated soils. . . . [These soils] can contribute significant amounts of volatile compounds to the air or be the source of dissolved contaminants in ground water. . . . Today's final regulations leave the off-site management of these concerns to existing state and local requirements.

This statement makes it clear that a pile of petroleum-saturated soil in a confined area could result in vapor accumulation to explosive levels. Further, soils saturated with free product could also ignite if exposed to flame or heat. Therefore, while a petroleum-contaminated soil may not be classifiable as ignitable under the hazardous waste regulations, these soils can present a flammability hazard if not properly managed. You will find more on proper on-site and off-site soil management in Part 2, Section 3, Proper Management of Spill Residuals and Debris.

c. Oxygen-Deficient Environments

A reading of less than 20.9 percent oxygen content is indicative of an oxygen-deficient atmosphere. Sustained oxygen levels below 16 percent are life threatening. You are most likely to encounter depressed oxygen levels in confined, poorly ventilated spaces such as (but not limited to) basements, belowground utility vaults, sewers, or the interior of a tank. Simple asphyxiants such as methane, nitrogen, and carbon dioxide can also displace the air in a confined space resulting in decreased oxygen levels, and chemical reactions that utilize oxygen can result in decreased atmospheric oxygen levels.

**NOTES**

You should always measure oxygen levels (and take a LEL reading) with an oxygen meter or combined oxygen meter-explosimeter before entering a confined area. If your measurements indicate an oxygen-deficient atmosphere, take steps to increase ventilation of the area until the oxygen level is safe, and/or use breathing equipment that would allow you to enter the area safely.[2]

d. Heat and Cold Stress

Heat or cold stress can be a concern. If you anticipate having to deal with temperature extremes, know how to recognize the symptoms of heat or cold stress, know how to deal with their effects, and have the necessary materials on hand to deliver treatment. Additional information on the recognition and treatment of heat or cold stress is contained in Appendix P ("Recognition and Treatment of Heat and Cold Stress"). Review the material in this appendix carefully.

e. Noise Hazards

Excessive noise levels can represent two kinds of hazards. The first and most obvious is that high noise levels can cause discomfort, pain, or a temporary or permanent hearing loss. You should avoid working in any environment where noise levels are above your discomfort threshold without the use of hearing protection. A noise emanating from a stressed container may also be a warning of impending container failure, requiring appropriate safety precautions.

The second hazard associated with excessive noise is the inability to communicate effectively with others at the incident scene. Your own hearing and that of others is also reduced when you and others are wearing many types of personal protective equipment. Make sure communication between yourself and others at the incident site is audible and clear, and monitor your own surroundings.

f. Ionizing Radiation

You may encounter spills that expose you to ionizing radiation hazards. There are three main types of ionizing radiation: alpha, beta, and gamma. A Geiger-Mueller radiation meter can be used to detect all three of these forms of ionizing radiation.

Alpha radiation travels approximately one quarter of an inch in air with little penetrating power. It does not pose a substantive health risk when the source is external to the human body. If an alpha-emitting source is

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[2] *Although rare, you may find that taking oxygen level readings in a confined space in the presence of leaking oxygen gas cylinders or after the reaction of an oxidizing agent (e.g., potassium permanganate) can result in an oxygen reading greater than 21 percent. An oxygen level of greater than 21 percent will affect the validity of combustible gas indicator readings.*

ingested or inhaled accidentally, however, alpha radiation will pose a significant health threat. Both beta and gamma radiation emanating from an external source can penetrate human skin causing damage to the skin and underlying blood vessels. Gamma radiation has the greatest penetrating power and can appreciably damage internal organs if exposure is substantial.

The typical background radiation level at sea level in New York State is approximately 0.01 millirems per hour. **At levels greater than 2 millirems per hour, cease all site activities and evacuate the work area.**

g. Mechanical or Physical Safety Hazards

There are numerous mechanical and physical safety hazards that may be encountered at an incident scene. Among the more common of these hazards are the following:

- Holes or ditches;
- Electrical shock;
- Sharp objects;
- Slippery surfaces and steep grades;
- Unstable surfaces (such as in a trench); and
- Heavy equipment operation.

Many of these hazards can be compounded by loss of foot and hand dexterity, decrease in peripheral vision, and added body heat load that occurs when an individual is outfitted with some kinds of personal protective equipment.

Since it is often difficult for heavy equipment operators to see or hear other workers around them (especially when the equipment operator is also wearing personal protective equipment), exercise caution while working around such equipment or avoid working in the same area while such equipment is operating. Warning sounds or lights may not be sufficient to alert the preoccupied worker. If you must work in the vicinity of operating heavy equipment, maintain eye contact with the operator.

The use of low-voltage electrical equipment with ground-fault interrupters and water-tight, corrosion-resistant connecting cables should help to minimize the hazard associated with the use of electrical systems on-site. You should also determine the location(s) of underground electrical cables and overhead power lines so that response actions can be planned accordingly. In general, heavy equipment should not be operated within 15 feet of overhead power lines.

h. Working In or Near Water

**NOTES**

When working in, on, or near the water, be sure that you have on proper clothing and a life jacket. Always work in teams of at least two people, and be conscious of currents. If you work in or from a boat, be sure to balance the load you carry and move about carefully. Exercise extra caution when working with electricity near water.

i. Working in High Crime Areas

BSPR personnel should always be alert to the possibility of crimes being committed against them while performing their duties, particularly in areas where the crime rate is high (e.g., many sections of New York City). Not only can DEC equipment be stolen or vandalized, but BSPR personnel can be robbed or assaulted as well. In order to lessen the chances of being a crime victim, BSPR personnel should follow these recommendations:

# Work in groups of two or more whenever possible;

# Lock-up vehicles and close windows;

# Don't leave equipment unattended;

# Do not enter areas where trouble seems likely;

# Request police assistance when encountering an actual or threatening emergency situation; and

# Do not carry large amounts of cash, and do not wear valuables such as expensive watches and jewelry.

Should you become the victim of a crime or witness a crime, immediately report the incident to the local police. If you have been assaulted or have witnessed an assault that involves an obvious or suspected injury, call for an ambulance and report the incident to the police as well.

j. Hazards During Removal of Underground Storage Tanks

BSPR personnel should be aware of several safety and health hazards present during removal[3] of underground storage tanks (UST). The

*[3] UST removal, as used in this subsection, refers to the operation of removing the UST from the ground following tank off-loading.*

hazards, many of which could be life threatening, including the following:

- # Fire/explosion involving the UST or product that has leaked out;
- # Cave-in of the excavation site;
- # Electrical hazards if underground or overhead power cables are accidentally damaged;
- # Fire hazard if underground natural gas lines are accidentally damaged;
- # Improperly supported heavy equipment (e.g., crane); and
- # Inhalation of hazardous vapors.

The greatest hazard is that of fire and/or explosion. Flammable vapors, possibly within their flammability range (i.e., range between upper and lower explosive limits), are very likely to be present, especially if the tank has holes, cracks, or tears. Open flames, lit smoking materials, or sparks from any source (e.g., frictional sparking, static sparking) could result in ignition of flammable vapors and, possibly, explosion of the tank. Regarding explosion, tanks that are empty or near empty are at the greatest risk of explosion due to the amount of vapor space within the tank. A tank that has been removed from the ground presents the possibility of a tank explosion involving rocketing of the tank ends and 360 degree scattering of tank fragments.

Other safety hazards face UST removal crews, as well. Backhoes may unintentionally damage underground electrical or natural gas lines, especially when equipment operators have no idea that these lines are present. Backhoe operators must also be careful not to inflict damage to the UST. As the excavation deepens, there is a real possibility of cave-in occurring unless the backhoe is located far enough away and the excavation is properly shored. When the tank lifting operation is taking place, the involved crane can present several hazards. If it has not been properly supported and stabilized, the crane can fall over, and if it is too close to the excavation, the excavation may collapse and, possibly, result in the crane or at least its boom falling into the trench and on top of the UST. While operating, the crane may also come in contact with any on-site power lines, thus, causing an electrocution hazard.

Removal of USTs can also present a health hazard; that of hazardous vapor inhalation. Even petroleum products, common UST commodities, can be harmful to inhale due to hazardous and/or carcinogenic vapors such as benzene, toluene, and xylene. Other UST commodities, such as solvents, will likely pose acute and/or chronic health hazards, as well.

**NOTES**

Despite the hazards involved in the removal of USTs, BSPR and other people involved in the operation can take several precautions and mitigative actions to prevent accidents and lessen the impact of these hazards. Precautions and mitigative actions include, but are not limited to, the following:

- # Establish a site safety plan and ensure that all on-site personnel abide by it.

- # Eliminate all sources of ignition, and strictly enforce a "No Smoking" policy at the removal site.

- # Throughout the removal operation, monitor for flammable/hazardous vapors, and cease operations whenever vapors reach 20% of the lower explosive limit.

- # Wear appropriate protective clothing.

- # Have at least one fire extinguisher, with a minimum rating of 20BC, readily available. (A rating of 20BC indicates that the extinguisher will, upon proper usage, effectively extinguish a 20 square foot area of fire involving a flammable liquid and that it can also be used to safely extinguish electrical fires.)

- # Keep unnecessary people away from the excavation and heavy equipment.

- # Prior to excavating (the top of the tank will have been excavated during tank closure):

  - -- Check the locations of underground and overhead electrical and other utility lines so that you can avoid damaging or contacting them;

  - -- Introduce an inert material (e.g., nitrogen gas, dry ice) into the tank to reduce the changes of ignition of vapors (the atmosphere inside the tank must be lowered to less than 20% of the lower explosive limit);

  - -- Plug or cap all accessible holes at the top of the tank;

  - -- Take and analyze soil samples around the tank;

  - -- Position a supervisor in a location where he/she can safely observe the excavation operation and remain in radio or visual contact with the backhoe operator. (Note: Radios, if used, should be intrinsically safe.)

**NOTES**

- # During the excavation operation, ensure that the backhoe maintains a safe distance away from the excavation and that excavated materials are placed at least two feet back from the edge.

- # Prior to the tank lifting (removal) operation:

  -- Ensure that the crane is fully capable of lifting the tank;

  -- Position the crane away from overhead wires and far enough back from the excavation to prevent cave-in;

  -- Ensure that the crane has been adequately stabilized;

  -- When personnel enter the trench to attach lifting straps around the tank, the trench must first be monitored to ensure that safe entry is possible and shored in accordance with OSHA regulations; and

  -- Position a supervisor in a location where he/she can safely observe the removal operation and remain in radio or visual contact with the crane operator.

- # During the removal operation:

  -- Ensure that the crane maintains a safe distance away from the trench;

  -- Cease operations if the sling/cable supporting the tank comes loose or appears weakened or overstressed;

  -- Ensure that the removed tank is carefully placed onto the awaiting transport truck and secured to the truck tightly;

  -- If the tank is leaking any liquid product, initiate appropriate emergency response actions (refer to Part 1, Section 3, Emergency Response).

## 7. Health and Safety Reference Materials

There are many good reference materials on health and safety regulations and practices. Those suggested for your office library or spill response vehicle include the following:

- # National Institute for Occupational Safety and Health. 1985. "Pocket Guide to Chemical Hazards." The NIOSH Pocket Guide provides OSHA-PELs, IDLHs, chemical, physical data, personnel protection information, and first aid information.

- **#** American Conference of Governmental Industrial Hygienists. 1988-89. Threshold Limit Values for Chemical Substances and Physical Agents in the Workplace Environment and Biological Exposure Indices with Intended Changes for 1989-90. The "TLV Handbook" provides TLV-TWAs, TLV-STELs, TLV-ceiling values, chemical abstract service numbers, special appendices on such classes of chemicals as carcinogens and asphyxiants, and information on physical hazards such as ionizing and non-ionizing radiation.

- **#** National Institute of Health and Human Services, Public Health Service, Centers for Disease Control. 1984. Personal Protective Equipment for Hazardous Materials Incidents: A Selection Guide. Publication No. 84-1141.

- **#** U.S. Department of Transportation. Guidebook for Hazardous Materials Incidents (1987 Emergency Response Guidebook)

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**NOTES**


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5. Hazardous Materials: Managing the Incident, Noll, Hildebrand, and Yvorra, Fire Protection Publications, 1988, pp. 174-180.

6. Threshold Limit Values and Biological Exposure Indices for 1987-1988, p. 4.

7. NIOSH Pocket Guide to Chemical Hazards, p. 14.

Attachment 2.1-1

# Types of Personal Protective Equipment and Accessories

Protective Clothing and Accessories

| BODY PART PROTECTED | TYPE OF CLOTHING OR ACCESSORY | DESCRIPTION | TYPE OF PROTECTION | USE CONSIDERATIONS |
|---|---|---|---|---|
| Full Body | Fully-encapsulating suit | One-piece garment. Boots and gloves may be integral, attached and replaceable, or separate. | Protects against splashes, dust, gases, and vapors. | Does not allow body heat to escape. May contribute to heat stress in wearer, particularly if worn in conjunction with a closed-circuit SCBA; a cooling garment may be needed. Impairs worker mobility, vision, and communication. |
| | Non-encapsulating suit | Jacket, hood, pants, or bib overalls, and one-piece coveralls. | Protects against splashes, dust, and other materials but not against gases and vapors. Does not protect parts of head or neck. | Do not use where gas-tight or pervasive splashing protection is required.<br>May contribute to heat stress in wearer.<br>Tape-seal connections between pant cuffs and boots and between gloves and sleeves. |
| | Aprons, leggings, and sleeve protectors | Fully sleeved and gloved apron.<br>Separate coverings for arms and legs.<br>Commonly worn over non-encapsulating suit. | Provides additional splash protection of chest, forearms, and legs. | Whenever possible, should be used over a non-encapsulating suit (instead of using a fully-encapsulating suit) to minimize potential for heat stress.<br>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 (NFPA No. 1971, 1972, 1973), and boots. | Protects against heat, hot water, and some particles. Does not protect against gases and vapors, or chemical permeation or degradation. NFPA Standard No. 1971 specifies that a garment consist of an outer shell, an inner liner, and a vapor barrier with a minimum water penetration of 25 lbs/in² (1.8 kg/cm²) to prevent the passage of hot water. | Decontamination is difficult.<br>Should not be worn in areas where protection against gases, vapors, chemical splashes, or permeation is required. |
| | Proximity garment (approach suit) | One- or two-piece overgarment with boot covers, gloves, and hood of aluminized nylon or cotton fabric.<br>Normally worn over other protective clothing, such as chemical-protective clothing, firefighters' bunker gear, or flame-retardant coveralls. | Protects against brief exposure to radiant heat. Does not protect against chemical permeation or degradation.<br>Can be custom-manufactured to protect against some chemical contaminants. | Auxiliary cooling and an SCBA should be used if the wearer may be exposed to a toxic atmosphere or needs more than 2 or 3 minutes of protection. |
| | Blast and fragmentation suit | Blast and fragmentation vests and clothing, bomb blankets, and bomb carriers. | Provides some protection against very small detonations. Bomb blankets and baskets can help redirect a blast. | Does not provide hearing protection. |

## Types of Personal Protective Equipment and Accessories (continued)

(cont.)

| BODY PART PROTECTED | TYPE OF CLOTHING OR ACCESSORY | DESCRIPTION | TYPE OF PROTECTION | USE CONSIDERATIONS |
|---|---|---|---|---|
| Full Body (cont.) | Radiation-contamination protective suit | Various types of protective clothing designed to prevent contamination of the body by radioactive particles. | Protects against alpha and beta particles. *Does NOT protect against gamma radiation.* | Designed to prevent skin contamination. If radiation is detected on site, consult an experienced radiation expert and evacuate personnel until the radiation hazard has been evaluated. |
| | Flame/fire retardant coveralls | Normally worn as an undergarment. | Provides protection from flash fires. | Adds bulk and may exacerbate heat stress problems and impair mobility. |
| | Flotation gear | Life jackets or work vests. (Commonly worn underneath chemical protective clothing to prevent flotation gear degradation by chemicals.) | Adds 15.5 to 25 lbs (7 to 11.3 kg) of buoyancy to personnel working in or around water. | Adds bulk and restricts mobility. Must meet USCG standards (46 CFR Part 160). |
| | Cooling garment | One of three methods: (1) A pump circulates cool dry air throughout the suit or portions of it via an air line. Cooling may be enhanced by use of a vortex cooler, refrigeration coils, or a heat exchanger. (2) A jacket or vest having pockets into which packets of ice are inserted. (3) A pump circulates chilled water from a water/ice reservoir and through circulating tubes, which cover part of the body (generally the upper torso only). | Removes excess heat generated by worker activity, the equipment, or the environment. | (1) Pumps circulating cool air require 10 to 20 ft³ (0.3 to 0.6 m³) of respirable air per minute, so they are often uneconomical for use at a waste site. (2) Jackets or vests pose ice storage and recharge problems. (3) Pumps circulating chilled water pose ice storage problems. The pump and battery add bulk and weight. |
| Head | Safety helmet (hard hat) | For example, a hard plastic or rubber helmet. | Protects the head from blows. | Helmet shall meet OSHA standard 29 CFR Part 1910.135. |
| | Helmet liner | | 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 respiratory protective devices. | Particularly important for workers with long hair. |
| Eyes and Face* | Face shield | Full-face coverage, eight-inch minimum. | Protects against chemical splashes. Does not protect adequately against projectiles. | Face shields and splash hoods must be suitably supported to prevent them from shifting and exposing portions of the face or obscuring vision. Provides limited eye protection. |

*All eye and face protection must meet OSHA standard 29 CFR Part 1910.133.

## Types of Personal Protective Equipment and Accessories (continued)

(cont.)

| BODY PART PROTECTED | TYPE OF CLOTHING OR ACCESSORY | DESCRIPTION | TYPE OF PROTECTION | USE CONSIDERATIONS |
|---|---|---|---|---|
| **Eyes and Face** (cont.) | Splash hood | | Protects against chemical splashes.<br>Does not protect adequately against projectiles. | |
| | Safety glasses | | Protect eyes against large particles and projectiles. | If lasers are used to survey a site, workers should wear special protective lenses. |
| | Goggles | | Depending on their construction, goggles can protect against vaporized chemicals, splashes, large particles, and projectiles (if constructed with impact-resistant lenses). | |
| | Sweat bands | | Prevents sweat-induced eye irritation and vision impairment. | |
| **Ears** | Ear plugs and muffs | | Protect against physiological damage and psychological disturbance. | Must comply with OSHA regulation 29 CFR Part 1910.95. Can interfere with communication.<br>Use of ear plugs should be carefully reviewed by a health and safety professional because chemical contaminants could be introduced into the ear. |
| | Headphones | Radio headset with throat microphone. | Provide some hearing protection while enabling communication. | Highly desirable, particularly if emergency conditions arise. |
| **Hands and Arms** | Gloves and sleeves | May be integral, attached, or separate from other protective clothing. | Protect hands and arms from chemical contact. | Wear jacket cuffs over glove cuffs to prevent liquid from entering the glove.<br>Tape-seal gloves to sleeves to provide additional protection. |
| | | 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 decontamination needs. | |
| Foot | Safety boots | Boots constructed of chemical-resistant material. | Protect feet from contact with chemicals. | |
| | | Boots constructed with some steel materials (e.g., toes, shanks, insoles). | Protect feet from compression, crushing, or puncture by falling, moving, or sharp objects. | All boots must at least meet the specifications required under OSHA 29 CFR Part 1910.136 and should provide good traction. |
| | | Boots constructed from nonconductive, spark-resistant materials or coatings. | Protect the wearer against electrical hazards and prevent ignition of combustible gases or vapors. | |

Attachment 2.1-1

Types of Personal Protective Equipment
and Accessories
(continued)

(cont.)

| BODY PART PROTECTED | TYPE OF CLOTHING OR ACCESSORY | DESCRIPTION | TYPE OF PROTECTION | USE CONSIDERATIONS |
|---|---|---|---|---|
| **Foot (cont.)** | Disposable shoe or boot covers | Made of a variety of materials. 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 decontamination. |
| **General** | Knife | | Allows a person in a fully-encapsulating suit to cut his or her way out of the suit 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 flashlight in a plastic bag facilitates decontamination. Only electrical equipment approved as intrinsically safe, or approved for the class and group of hazard as defined in Article 500 of the National Electrical Code, may be used. |
| | 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 of communicate with personnel in the Support Zone. | |
| | Safety belts, harnesses, and lifelin' | | Enable personnel to work in elevated areas or enter confined areas and prevent falls. Belts may be used to carry tools and equipment. | Must be constructed of spark-free hardware and chemical-resistant materials to provide proper protection. Must meet OSHA standards in 29 CFR Part 1926.104. |

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

# Attachment 2.1-2

## Sample Protective Ensembles

Sample Protective Ensembles*

| LEVEL OF PROTECTION | EQUIPMENT | PROTECTION PROVIDED | SHOULD BE USED WHEN: | LIMITING CRITERIA |
|---|---|---|---|---|
| A | RECOMMENDED:<br>• Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA.<br>• Fully-encapsulating, chemical-resistant suit.<br>• Inner chemical-resistant gloves.<br>• Chemical-resistant safety boots/shoes.<br>• Two-way radio communications.<br>OPTIONAL:<br>• Cooling unit.<br>• Coveralls.<br>• Long cotton underwear.<br>• Hard hat.<br>• Disposable gloves and boot covers. | The highest available level of respiratory, skin, and eye protection. | • The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either:<br>— measured (or potential for) high concentration of atmospheric vapors, gases, or particulates<br>or<br>— site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin.<br>• Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible.<br>• Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined. | • Fully-encapsulating suit material must be compatible with the substances involved. |
| B | RECOMMENDED:<br>• Pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA.<br>• Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit).<br>• Inner and outer chemical-resistant gloves.<br>• Chemical-resistant safety boots/shoes.<br>• Hard hat.<br>• Two-way radio communications.<br>OPTIONAL:<br>• Coveralls.<br>• Disposable boot covers.<br>• Face shield.<br>• Long cotton underwear. | The same level of respiratory protection but less skin protection than Level A.<br>It is the minimum level recommended for initial site entries until the hazards have been further identified. | • The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres:<br>— with IDLH concentrations of specific substances that do not represent a severe skin hazard;<br>or<br>— that do not meet the criteria for use of air-purifying respirators.<br>• Atmosphere contains less than 19.5 percent oxygen.<br>• Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin. | • Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin.<br>• Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin. |

*Based on EPA protective ensembles.

## Attachment 2.1-2

## Sample Protective Ensembles
## (continued)

**Table 8-6.** (cont.)

| LEVEL OF PROTECTION | EQUIPMENT | PROTECTION PROVIDED | SHOULD BE USED WHEN: | LIMITING CRITERIA |
|---|---|---|---|---|
| C | RECOMMENDED:<br>• Full-facepiece, air-purifying, canister-equipped respirator.<br>• Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit).<br>• Inner and outer chemical-resistant gloves.<br>• Chemical-resistant safety boots/shoes.<br>• Hard hat.<br>• Two-way radio communications.<br>OPTIONAL:<br>• Coveralls.<br>• Disposable boot covers.<br>• Face shield.<br>• Escape mask.<br>• Long cotton underwear. | The same level of skin protection as Level B, but a lower level of respiratory protection. | • The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin.<br>• The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant.<br>• All criteria for the use of air-purifying respirators are met. | • Atmospheric concentration of chemicals must not exceed IDLH levels.<br>• The atmosphere must contain at least 19.5 percent oxygen. |
| D | RECOMMENDED:<br>• Coveralls.<br>• Safety boots/shoes.<br>• Safety glasses or chemical splash goggles.<br>• Hard hat.<br>OPTIONAL:<br>• Gloves.<br>• Escape mask.<br>• Face shield. | No respiratory protection. Minimal skin protection. | • The atmosphere contains no known hazard.<br>• Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals. | • This level should not be worn in the Exclusion Zone.<br>• The atmosphere must contain at least 19.5 percent oxygen. |

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

## Attachment 2.1-3

## Relative Advantages & Disadvantages of Respiratory Protective Equipment

| TYPE OF RESPIRATOR | ADVANTAGES | DISADVANTAGES |
|---|---|---|
| **ATMOSPHERE-SUPPLYING** | | |
| **Self-Contained Breathing Apparatus (SCBA)** | • Provides the highest available level of protection against airborne contaminants and oxygen deficiency.<br>• Provides the highest available level of protection under strenuous work conditions. | • Bulky, heavy (up to 35 pounds).<br>• Finite air supply limits work duration.<br>• May impair movement in confined spaces. |
| **Positive-Pressure Supplied-Air Respirator (SAR)** (also called air-line respirator) | • Enables longer work periods than an SCBA.<br>• Less bulky and heavy than a SCBA. SAR equipment weighs less than 5 pounds (or around 15 pounds if escape SCBA protection is included).<br>• Protects against most airborne contaminants. | • Not approved for use in atmospheres immediately dangerous to life or health (IDLH) or in oxygen-deficient atmospheres unless equipped with an emergency egress unit such as an escape-only SCBA that can provide immediate emergency respiratory protection in case of air-line failure.<br>• Impairs mobility.<br>• MSHA/NIOSH certification limits hose length to 300 feet (90 meters).<br>• As the length of the hose is increased, the minimum approved air flow may not be delivered at the facepiece.<br>• Air line is vulnerable to damage, chemical contamination, and degradation. Decontamination of hoses may be difficult.<br>• Worker must retrace steps to leave work area.<br>• Requires supervision/ monitoring of the air supply line. |
| **AIR-PURIFYING** | | |
| **Air-Purifying Respirator** (including powered air-purifying respirators [PAPRs]) | • Enhanced mobility.<br>• Lighter in weight than an SCBA. Generally weights 2 pounds (1 kg) or less (except for PAPRs). | • Cannot be used in IDLH or oxygen-deficient atmospheres (less than 19.5 percent oxygen at sea level).<br>• Limited duration of protection. May be hard to gauge safe operating time in field conditions.<br>• Only protects against specific chemicals and up to specific concentrations.<br>• Use requires monitoring of contaminant and oxygen levels.<br>• Can only be used (1) against gas and vapor contaminants with adequate warning properties, or (2) for specific gases or vapors provided that the service is known and a safety factor is applied or if the unit has an ESLI (end-of-service-life indicator). |

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

## Attachment 2.1-4

## Types of Self-Contained Breathing Apparatus (SCBA)

| TYPE | DESCRIPTION | ADVANTAGES | DISADVANTAGES | COMMENTS |
|---|---|---|---|---|
| **ENTRY-AND-ESCAPE SCBA** | | | | |
| Open-Circuit SCBA | Supplies clean air to the wearer from a cylinder. Wearer exhales air directly to the atmosphere. | Operated in a positive-pressure mode, open-circuit SCBAs provide the highest respiratory protection currently available. A warning alarm signals when only 20 to 25 percent of the air supply remains. | Shorter operating time (30 to 60 minutes) and heavier weight (up to 35 lbs [13.6 kg]) than a closed-circuit SCBA. | The 30- to 60-minute operating time may vary depending on the size of the air tank and the work rate of the individual. |
| Closed-Circuit SCBA (Rebreather) | These devices recycle exhaled gases ($CO_2$, $O_2$, and nitrogen) by removing $CO_2$ with an alkaline scrubber and replenishing the consumed oxygen with oxygen from a liquid or gaseous source. | Longer operating time (up to 4 hours), and lighter weight (21 to 30 lbs [9.5 to 13.6 kg]) than open-circuit apparatus.<br>A warning alarm signals when only 20 to 25 percent of the oxygen supply remains.<br>Oxygen supply is depleted before the $CO_2$ sorbent scrubber supply, thereby protecting the wearer from $CO_2$ breakthrough. | At very cold temperatures, scrubber efficiency may be reduced and $CO_2$ breakthrough may occur.<br>Units retain the heat normally exchanged in exhalation and generate heat in the $CO_2$ scrubbing operations, adding to the danger of heat stress. Auxiliary cooling devices may be required.<br>When worn outside an encapsulating suit, the breathing bag may be permeated by chemicals, contaminating the breathing apparatus and the respirable air. Decontamination of the breathing bag may be difficult. | Positive-pressure closed-circuit SCBAs offer substantially more protection than negative-pressure units, which are not recommended on hazardous waste sites. While these devices may be certified as closed-circuit SCBAs, NIOSH cannot certify closed-circuit SCBAs as positive-pressure devices due to limitations in certification procedures currently defined in 30 CFR Part 11. |
| **ESCAPE-ONLY SCBA** | Supplies clean air to the wearer from either an air cylinder or from an oxygen-generating chemical. Approved for escape purposes only. | Lightweight (10 pounds [4.5 kg] or less), low bulk, easy to carry.<br>Available in pressure-demand and continuous-flow modes. | Cannot be used for entry. | Provides only 5 to 15 minutes of respiratory protection, depending on the model and wearer breathing rate. |

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

**Selecting Chemical Protective Clothing**

SELECTING CHEMICAL PROTECTIVE CLOTHING

Selecting the most effective chemical protective clothing is easier when the chemical for which protection is necessary is known. Selection becomes more difficult when the presence of chemicals is unknown, multiple chemicals (known or unknown) are involved, or an unidentifiable substance is present. As uncertainties about the substances involved increases, selecting the proper clothing becomes more difficult.

Another major difficulty in selection is that there is not enough available information concerning the protective qualities of commonly used protective materials against the wide range of chemicals that could be encountered.

The selection process consists of:

- Deciding that workers must be in an environment where they could be exposed.
- Identifying the chemical involved and determining its physical, chemical, and toxicological properties.
- Deciding whether, at the concentrations known or expected, the substance is a skin hazard.
- Selecting protective material which provides the least permeation and degradation for the longest period of time.
- Determining whether a fully encapsulating suit or a non-encapsulating is required.
- Determining the physical limitations of the clothing based upon job activity and site conditions.

In those incidents where the presence of hazardous substances is not known or they can not be readily identified there are usually clues which can assist in choosing the style of clothing. Observations which could indicate wearing fully encapsulating suits are:

- Visible emissions of gases, vapors, dust or smoke.
- indications of airborne hazards on direct-reading instruments.
- configurations of containers or vehicles which indicate they contain gases or pressurized liquids.
- signs, labels, placards, or bills of lading indicating substances that could become airborne and are toxic to the skin.
- enclosed, poorly ventilated areas where toxic vapors, gases and other airborne substances could accumulate.
- work functions required might expose workers to high concentrations of skin toxics.

## Selecting Chemical Protective Clothing
(continued)

Unknown situations require considerable judgement as to whether maximum protection to the skin (fully encapsulating clothing) is necessary, or whether splash suits are appropriate.

After determining the type of protective garment to be worn, the next step is to select the protective material. Vendors or manufacturers of materials used to make chemical protective materials can sometimes (but not always) supply information concerning their product's chemical resistance and make recommendations about what chemicals it is good for. The number of chemicals their product is tested against may be limited, for they can not test against the 1000's of chemicals that exist.

Permeation is the primary selection criteria. The best protective material against a specific chemical would be one that has a very low permeation rate (if any), and a long breakthrough time, and has been constructed free of design imperfections.

Less useful information is degradation. This is usually a qualitative determination of a materials ability to standup under the attack of a chemical, usually expressed in subjective units of excellent, good, poor, or similar terms. Degradation data can help in assessing the protective capability of a materials, if no other data is available.

However, a fabric with good degradation resistance may be very permeable to the same chemical. Permeation and degradation are not directly related and cannot be used interchangeably. In those situations where a protective material can not be chosen because of uncertainty of the attack substance, there are some reasonable options.

- Select a protective material which protects against the greatest range of chemicals. There are generally garments made from butyl rubber, viton, or teflon. Chemicals against which these materials (or other materials) do not provide protection could possibly be eliminated as not being present.

- Clothing made of multiple protective material could be used. Garments consisting of butyl viton, neoprene viton, and neoprene-butyl are manufactured. If not commercially available, two garments made of different material could be worn with a disposal type garment on the outside.

Whether fully encapsulating or non-encapsulating clothing should be worn may not be self-evident. If based on an assessment of the situation it is determined that either style would provide effective protection other factors to consider would be:

- Ease in wearing: Non-encapsulating suits are easier to wear. Wearers are less prone to accidents for they have better visibility and the clothing is less cumbersome.

- Communications: It is more difficult to communicate in fully encapsulating suits.

**Selecting Chemical Protective Clothing (continued)**

- Decontamination: Fully encapsulating suits protect self-contained breathing apparatus, which are difficult to decontaminate, from being contaminated.
- Heat stress: Non-encapsulating clothing generally causes less heat stress. However as less area of the body is exposed by wearing gloves and hoods and taping hoods to respirator masks, there is little difference in the heat build-up of either style.
- Cost: Non-encapsulating garments are less expensive.

## VII. PHYSICAL STRESS

Wearing chemical protective clothing can cause problems. These involve heat stress, accident proneness, and fatigue. The major problem is heat stress caused by protective clothing interfering with the body's ability to cool itself. Clothing that provides a barrier against chemicals contacting the skin, prevents the efficient dissipation of body heat. Evaporation, the body's primary cooling mechanism is reduced, since ambient air is not in contact with the skin's surface. Other heat exchange mechanisms (convection and radiation) are also impeded. Additional strain is put on the body as it attempts to maintain it's heat balance. This added stress can result in health effects ranging from transient heat fatigue to serious illness or death.

Source: Hazardous Materials Incident Response Operations, EPA, Office of Emergency and Remedial Response, Hazardous Response Support Division, 1988.

Attachment 2.1-6

**Rationale for Relating Total Atmospheric Vapor/Gas Concentrations to the Selection of the Level of Protection**

# RATIONALE FOR RELATING TOTAL ATMOSPHERIC VAPOR/GAS CONCENTRATIONS TO THE SELECTION OF THE LEVEL OF PROTECTION

## I. INTRODUCTION

The objective of using total atmospheric vapor/gas concentrations for determining the appropriate Level of Protection is to provide a numerical criterion for selecting Level A, B, or C. In situations where the presence of vapors or gases is not known, or if present, the individual components are unknown, personnel required to enter that environment must be protected. Until the constituents and corresponding atmospheric concentrations of vapor, gas, or particulate can be determined and respiratory and body protection related to the toxicological properties of the identified substances chosen, total vapor/gas concentration, with judicious interpretation, can be used as a guide for selecting personnel protection equipment.

Although total vapor/gas concentration measurements are useful to a qualified professional for the selection of protective equipment, caution should be exercised in interpretation. An instrument does not respond with the same sensitivity to several vapor/gas contaminants as it does to a single contaminant. Also since total vapor/ gas field instruments "see" all contaminants in relation to a specific calibration gas, the concentration of unknown gases or vapors may be over or under-estimated.

Suspected carcinogens, particulates, highly hazardous substances, infectious wastes, or other substances that do not elicit an instrument response may be known or suspected to be present. Therefore, the protection level should not be based solely on the total vapor/gas criterion. Rather, the level should be selected, case-by-case, with special emphasis on potential exposure from the chemical and toxicological characteristics of the known or suspected material.

## II. FACTORS FOR CONSIDERATION

In utilizing total atmospheric vapor/gas concentrations as a guide for selecting a Level of Protection, a number of other factors should also be considered:

**Rationale for Relating Total Atmospheric Vapor/Gas Concentrations to the Selection of the Level of Protection (continued)**

- The uses, limitations, and operating characteristics of the monitoring instruments must be recognized and understood. Instruments such as the HNU Photoionizer, Foxboro Organic Vapor Analyzer (OVA), MIRAN Infrared Spectrophotometer, and others do not respond identically to the same concentration of a substance or respond to all substances. Therefore, experience, knowledge, and good judgement must be used to complement the data obtained with instruments.

- Other hazards may exist such as gases not detected by the HNU or OVA, (i.e. phosgene, cyanides, arsenic, chlorine), explosives, flammable materials, oxygen deficiency, liquid/solid particles, and liquid or solid chemicals.

- Vapors/gases with a very low Threshold Limit Value (TLV) or Immediately Dangerous to Life and Health (IDLH) value could be present. Total readings on instruments, not calibrated to these substances, may not indicate unsafe conditions.

- The risk to personnel entering an area must be weighed against the need for entering. Although this assessment is largely a value judgment, it requires a conscientious balancing of the variables involved and the risk to personnel against the need to enter an unknown environment.

- The knowledge that suspected carcinogens or substances extremely toxic or destructive to skin are present or suspected to be present (which may not be reflected in total vapor/gas concentration) requires an evaluation of factors such as the potential for exposure, chemical characteristics of the material, limitation of instruments, and other considerations specific to the incident.

- What needs to be done on-site must be evaluated. Based upon total atmospheric vapor concentrations, Level C protection may be judged adequate; however, tasks such as moving drums, opening containers, and bulking of materials, which increase the probability of liquid splashes or generation of vapors, gases, or particulates, may require a higher level of protection.

- Before any respiratory protective apparatus is issued, a respiratory protection program must be developed and implemented according to recognized standards (ANSI Z88.2-1980).

## III. LEVEL A PROTECTION (500 to 1,000 PPM ABOVE BACKGROUND)

Level A protection provides the highest degree of respiratory tract, skin, and eye protection if the inherent limitations of the personnel protective equipment are not exceeded. The range of 500 to 1,000 parts per million (ppm) total vapors/gases concentration in air was selected based on the following criteria:

- Although Level A provides protection against air concentrations greater than 1,000 ppm for most substances, an operational restriction of 1,000 ppm is established as a warning flag to:
    - Evaluate the need to enter environments with unknown concentrations greater than 1,000 ppm.
    - Identify the specific chemical constituents contributing to the total concentration and their associated toxic properties.
    - Determine more precisely the concentrations of constituent chemicals.
    - Evaluate the calibration and/or sensitivity error associated with the instrument(s).
    - Evaluate instrument sensitivity to wind velocity, humidity temperature, etc.
- A limit of 500 ppm total vapors/gases in air was selected as the value to consider upgrading from Level B to Level A. This concentration was selected to fully protect the skin until the constituents can be identified and measured and substances affecting the skin excluded.
- The range of 500 to 1,000 ppm is sufficiently conservative to provide a safe margin of protection if readings are low due to instrument error, calibration, and sensitivity; if higher than anticipated concentrations occur; and if substances highly toxic to the skin are present.

With properly operating portable field equipment, ambient air concentrations approaching 500 ppm have not routinely been encountered on hazardous waste sites. High concentrations have been encountered only in closed buildings, when containers were being opened, when personnel were working in the spilled contaminants, or when organic vapors/gases were released in transportation accidents. A decision to require Level A protection should also consider the negative aspects: higher probability of accidents due to cumbersome equipment, and most importantly, the physical stress caused by heat buildup in fully encapsulating suits.

## IV. LEVEL B PROTECTION (5 to 500 ABOVE BACKGROUND)

Level B protection is the minimum Level of Protection recommended for initially entering an open site where the type, concentration, and presence of airborne vapors are unknown. This Level of Protection provides a high degree of respiratory protection. Skin and eyes are also protected, although a small portion of the body (neck and sides of head) may be exposed. The use of a separate hood or hooded, chemical-resistant jacket would further reduce the potential for exposure to this area of the body. Level B impermeable protective clothing also increases the probability of heat stress.

A limit of 500 ppm total atmospheric vapor/gas concentration on portable field instruments has been selected as the upper restriction on the use of Level B. Although Level B personnel protection should be adequate for most commonly encountered substances at air concentrations higher than 500 ppm, this limit has been selected as a decision point for a careful evaluation of the risks associated with higher concentrations. These factors should be considered:

- The necessity for entering unknown concentrations higher than 500 ppm wearing Level B protection.
- The probability that substance(s) present are severe skin hazards.
- The work to be done and the increased probability of exposure.
- The need for qualitative and quantitative identification of the specific components.
- Inherent limitations of the instruments used for air monitoring.
- Instrument sensitivity to winds, humidity, temperature, and other factors.

## V. LEVEL C PROTECTION (BACKGROUND TO 5 PPM ABOVE BACKGROUND)

Level C provides skin protection identical to Level B, assuming the same type of chemical protective clothing is worn, but lesser protection against inhalation hazards. A range of background to 5 ppm above ambient background concentrations of vapors/gases in the atmosphere has been established as guidance for selecting Level C protection. Concentrations in the air of unidentified vapors/gases approaching or exceeding 5 ppm would warrant upgrading respiratory protection to a self-contained breathing apparatus.

A full-face, air-purifying mask equipped with an organic vapor canister (or a combined organic vapor/particulate canister) provides protection against low concentrations of most common organic vapors/ gases. There are some substances against which full-face, canister equipped masks do not protect, or substances that have very low TLVs or IDLH concentrations. Many of the latter substances are gases or liquids in their normal state. Gases would only be found in gas cylinders, while the liquids would not ordinarily be found in standard containers or drums.

Every effort should be made to identify the individual constituents (and the presence of particulates) contributing to the total vapor readings of a few parts per million. Respiratory protective equipment can then be selected accordingly. It is exceedingly difficult, however, to provide constant, real-time identification of all components, with concentrations of a few parts per million, in a vapor cloud, at a site where ambient concentrations are constantly changing.

If highly toxic substances have been ruled out, but ambient levels of a few parts per million persist, it is unreasonable to assume only self-contained breathing apparatus should be worn. The continuous use of air-purifying masks in vapor/gas concentrations of a few parts per million gives a reasonable assurance that the respiratory tract is protected, provided that the absence of highly toxic substances has been confirmed.

Full-face, air-purifying devices provide respiratory protection against most vapors at greater than 5 ppm; however, until more definitive qualitative information is available, concentration(s) greater than 5 ppm indicates that a higher level of respiratory protection should be used. Also, unanticipated transient excursions may increase the concentrations in the environment above the limits of air-purifying devices. The increased probability of exposure due to the work being done may require Level B protection, even though ambient levels are low.

## VI. INSTRUMENT SENSITIVITY

Although the measurement of total vapor/gas concentrations can be a useful adjunct to professional judgment in the selection of an appropriate Level of Protection, caution should be used in the interpretation of the measuring instrument's readout. The response of an instrument to a gas or vapor cloud containing two or more substances does not provide the same sensitivity as measurements involving the individual pure constituents. Hence the instrument readout may overestimate or underestimate the concentration of an unknown composite cloud. This same type of inaccuracy could also occur in measuring a single unknown substance with the instrument calibrated to a different substance. The idiosyncrasies of each instrument must be considered in conjunction with the other parameters in selecting the protection equipment needed.

Using the total vapor/gas concentration as a criterion used to determine Levels of Protection should provide protection against concentrations greater than the instrument's readout. However, when the upper limits of Level C and B are approached, serious consideration should be given to selecting a higher Level of Protection. Cloud constituents must be identified as rapidly as possible and Levels of Protection based on the toxic properties of the specific substances identified.

## VII. EXPLANATION OF PHRASE TOTAL ATMOSPHERIC VAPOR/GAS CONCENTRATION

The phrase "total atmospheric vapor/gas concentration" is commonly used to describe the readout, in ppm, on PIDs and FIDs. More correctly it should be called a dial reading or needle deflection. In atmospheres that contain a single vapor/gas or mixtures of vapors/gases that have not been identified, the instruments do not read the total vapors/gases present only the instrument's response. This response, as indicated by a deflection of the needle in the dial, does not indicate the true concentration. Accurate dial readings can only be obtained by calibrating the instrument to the substance being measured.

Source: Standard Operating Safety Guides, EPA, Office of Emergency and Remedial Response, 1988.

## Attachment 2.1-7

## Protective Materials

PROTECTIVE MATERIALS

There is a wide variety of protective materials. The following is a list of the more common materials used in CPC and segregated as elastomers or non-elastomers. The elastomers are not listed in any particular priority. The classes of chemicals rated as "good for" or "poor for" represent test data for both permeation breakthrough and permeation rate. They are general recommendations; there may be specific exceptions within each chemical class. Additional recommendations are made on a materials' physical properties. Sources consulted for this information included Guidelines for the Selection of Chemical Protective Clothing (ACGIH, Vol. 1, 1985) and manufacturer's literature. The costs are recent estimates and are subject to change.

A. Elastomers

Butyl Rubber: (Isobutylene/Isoprene Copolymer)

Good for: bases and many organics
heat and ozone resistance
decontamination

Poor for: aliphatic and aromatic hydrocarbons
gasoline
halogenated hydrocarbons
abrasion resistance

Chlorinated Polyethylene: (Cloropel, CPE)

Good for: aliphatic hydrocarbons
acids and bases
alcohols, phenols
abrasion and ozone

Poor for: amines, esters, ketones
halogenated hydrocarbons
cold temperature (becomes rigid)

Natural Rubber: (Polyisoprene)

Good for: alcohols

dilute acids and bases
flexibility

Poor for: organic chemicals
aging (affected by ozone)

Neoprene: (Chloroprene)

Good for: bases and dilute acids
peroxides
fuels and oils
aliphatic hydrocarbons
alcohols
glycols
phenols
abrasion and cut resistance

Poor for: halogenated hydrocarbons
aromatic hydrocarbons
ketones
concentrated acids

Nitrile Rubber: (Acrylonitrile rubber, Buna-N, NBR, hycar, paracril, krynac)

Good for: phenols
PCBs
oils and fuels
alcohols
amines
bases
peroxides
abrasion and cut resistance
flexibility

Poor for: aromatic and halogenated hydrocarbons
amides
ketones
esters
cold temperature

Note: The higher the acrylonitrile concentration, the better the chemical resistance; but also increases stiffness.

Polyurethane:

Good for: bases
aliphatic hydrocarbons
alcohols
abrasion resistance
flexibility - especially at cold temperatures

Poor for: halogenated hydrocarbons

Polyvinyl Alcohol: (PVA)

Good for: almost all organics
ozone resistance

Poor for: esters
ethers
acids and bases
water and water solutions
flexibility

Polyvinyl Chloride: (PVC)

Good for: acids and bases
some organics
amines, peroxides

Poor for: most organic compounds
cut and heat resistance
decontamination

Viton:

Good for: aliphatic and aromatic hydrocarbons
halogenated hydrocarbons
acids
decontamination
physical properties

Poor for: aldehydes
ketones
esters (oxygenated solvents)
amines

Teflon:

Teflon has become available for chemical protective suits. Limited permeation test data is published on teflon. Teflon, similar to viton, is thought to afford excellent chemical resistance against most chemicals. Teflon suits are relatively expensive ($2,000-$4,500).

Blends/Layers

CPC Manufacturers have developed a technique of layering materials to improve chemical resistance. Essentially one suit is designed with multiple layers. Some examples of layered fully encapsulating suits are viton/butyl (Trelleborg), viton/neoprene (MSA Vautex and Draeger), and butyl/neoprene (MSA Betex).

B. Non-Elastomers

Tyvek: (non-woven polyethylene fibers)

Good for: dry particulate and dust protection decontamination (disposable) lightweight

Poor for: chemical resistance (penetration/degradation)
durability

Recommendations: Used against toxic particulates but provides no chemical protection; worn over other CPC to prevent gross contamination of non-disposable items and under suits to replace cotton or nomex coveralls.

Polyethylene: (coated tyvek)

Good for: acids and bases
alcohols
phenols
aldehydes
decontamination (disposable)
lightweight

Poor for: halogenated hydrocarbons aliphatic and aromatic hydrocarbons physical properties (durability) penetration (stitched seams)

Recommendation: Provides limited chemical protection against concentrated liquids and vapors. Useful against low concentrations and those activities which do not create a high risk of splash; also worn over CPC to prevent gross contamination of non-disposables. The disposable poly-gloves and boots are considered "inner liners" and assist decontamination procedures.

Saranex: (laminated tyvek)

Good for: acids and bases
amines
some organics
PCBs
decontamination (disposable)
lightweight
durability

Poor for: halogenated hydrocarbons
aromatic hydrocarbons
stitched seams (penetration may occur)

Attachment 2.1-7

Protective Materials
(continued)

Recommendation: Provides greater chemical resistance and overall protection compared to polyethylene coated tyvek; useful for splash used to prevent contamination of non-disposable clothing.

Source: Hazardous Materials Incident Response Operations, EPA, Office of Emergency and Remedial Response, Hazardous Response Support Division, 1988.

Attachment 2.1-8

Compatibility Between Suit Materials and Chemicals

# "MATRIX B"

## RECOMMENDATIONS BY CHEMICAL CLASS

| | Butyl | CPE | Viton/Neoprene | Natural Rubber | Neoprene | Nitrile+PVC | Nitrile | PE | PV Alcohol | PVC | Viton | Butyl/Neoprene | Other Materials |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Acids, Carboxylic, Aliphatic** | | | | | | | | | | | | | |
| Unsubstituted | R | r | r | ** | rr | ** | rr | NN | ** | ** | ** | r | |
| Polybasic | | | | | rr | rr | rr | rr | n | rr | | | |
| **Aldehydes** | | | | | | | | | | | | | |
| Aliphatic and Alicyclic | RR | NN | r | ** | NN | nn | NN | ** | NN | NN | ** | r | |
| Aromatic and Hetrocyclic | rr | | n | nn | nn | n | nn | NN | rr | N | | r | |
| **Amides** | | | | | | | | | | | | | |
| Amides | rr | | | ** | nn | | nn | nn | | | nn | | |
| **Amines, Aliphatic & Alicyclic** | | | | | | | | | | | | | |
| Primary | ** | ** | n | NN | ** | | rr | | nn | ** | ** | | |
| Secondary | ** | | n | NN | nn | | ** | | ** | NN | ** | n | |
| Tertiary | ** | ** | | ** | ** | ** | ** | | ** | ** | rr | | |
| Polyamine | ** | | | NN | ** | | nn | | | NN | rr | | |
| **Cyanides** | | | | | | | | | | | | | |
| Cyanides | | | | | r | | | | | | | | |
| **Esters, Carboxylic** | | | | | | | | | | | | | |
| Formates | | | n | | | | | | | n | | n | |
| Acetates | ** | ** | n | NN | nn | nn | NN | NN | ** | NN | n | ** | |
| Higher Monobasic | nn | nn | ** | NN | nn | | nn | NN | rr | NN | | ** | |
| Polybasic | | | r | r | r | | ** | | | rr | | r | |
| Aromatic Phthalates | rr | | r | ** | ** | | ** | | | nn | rr | r | |
| **Ethers** | | | | | | | | | | | | | |
| Aliphatic | ** | rr | ** | NN | ** | ** | ** | | ** | ** | | ** | |

**Note:**
Class recommendations only for chemicals classes in which two or more chemicals have recommendations for a given material. Double asterisks (**) indicate a wide variation in ratings.

Source: Guidelines for the Selection of Chemical Protective Clothing; 3rd Edition; Feb. 1987; EPA, U.S. Coast Guard, Arthur D. Little, Inc., and Los Alamos National Laboratory.

## Attachment 2.1-8

### Compatibility Between Suit Materials and Chemicals (continued)

| | BUTYL | CPE | VITON/NEOPRENE | NATURAL RUBBER | NEOPRENE | NITRILE+PVC | NITRILE | PE | PV ALCOHOL | PVC | VITON | BUTYL/NEOPRENE | OTHER MATERIALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Halogen Compounds** | | | | | | | | | | | | | |
| Aliphatic, Unsubstituted | nn | nn | r | NN | NN | NN | NN | NN | ** | NN | ** | n | |
| Aliphatic, Substituted | ** | | | NN | rr | | nn | | ** | NN | rr | | |
| Aromatic, Unsubstituted | nn | nn | r | N | | n | nn | NN | | N | rr | n | |
| Polynuclear | | | | NN | nn | | | | | n | rr | | |
| Vinyl Halides | | | | | | | | | | n | rr | | |
| **Heterocyclic Compounds** | | | | | | | | | | | | | |
| Epoxy Compounds | ** | | | ** | nn | | nn | NN | ** | nn | NN | | |
| Furan Derivatives | nn | | nn | | | | | | | NN | nn | n | |
| **Hydrazines** | | | | | | | | | | | | | |
| Hydrazines | ** | nn | n | ** | ** | | ** | | nn | ** | ** | n | |
| **Hydrocarbons** | | | | | | | | | | | | | |
| Aliphatic & Alicyclic | N | r | r | NN | ** | ** | ** | ** | ** | NN | RR | n | |
| Aromatic | ** | rr | r | NN | NN | NN | ** | NN | ** | NN | RR | n | |
| **Hydroxyl Compounds** | | | | | | | | | | | | | |
| Aliphatic & Alicyclic, Primary | RR | rr | rr | nn | ** | nn | ** | ** | ** | ** | rr | ** | |
| Aliphatic & Alicyclic, Secondary | rr | rr | r | ** | ** | ** | rr | | rr | ** | rr | r | |
| Aliphatic & Alicyclic, Tertiary | r | | | ** | rr | rr | rr | | | ** | | | |
| Aliphatic & Alicyclic, Polyols | r | | ** | rr | rr | rr | rr | | | ** | | ** | |
| Aromatic | ** | | r | ** | ** | ** | ** | ** | nn | ** | rr | r | |
| **Inorganic Acids** | | | | | | | | | | | | | |
| Inorganic Acids | ** | ** | rr | ** | ** | ** | ** | ** | n | ** | rr | ** | |

Note:
Class recommendations only for chemicals classes in which two or more chemicals have recommendations for a given material. Double asterisks (**) indicate a wide variation in ratings.

# Attachment 2.1-8

## Compatibility Between Suit Materials and Chemicals (continued)

| | BUTYL | CPE | VITON/NEOPRENE | NATURAL RUBBER | NEOPRENE | NITRILE+PVC | NITRILE | PE | PV ALCOHOL | PVC | VITON | BUTYL/NEOPRENE | OTHER MATERIALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganic Bases** | | | | | | | | | | | | | |
| Inorganic Bases | r | r | | RR | RR | ** | RR | ** | n | ** | rr | r | |
| **Inorganic Gases** | | | | | | | | | | | | | |
| Inorganic Gases | ** | r | n | n | r | | | ** | | ** | ** | ** | |
| **Inorganic Salts** | | | | | | | | | | | | | |
| Inorganic Salts | r | | n | ** | r | r | r | | | R | | | |
| **Isocyanates** | | | | | | | | | | | | | |
| Isocyanates | | | | NN | n | | | | rr | | | | |
| **Ketones, Aliphatic** | | | | | | | | | | | | | |
| Ketones, Aliphatic | ** | NN | n | NN | NN | N | ** | NN | ** | NN | NN | ** | |
| **Nitriles, Aliphatic** | | | | | | | | | | | | | |
| Nitriles, Aliphatic | rr | | | NN | ** | | | NN | rr | NN | rr | | |
| **Nitro Compounds** | | | | | | | | | | | | | |
| Unsubstituted | rr | r | | NN | ** | | nn | | ** | ** | ** | | |
| **Organo-Phosphorous Compounds** | | | | | | | | | | | | | |
| Orgno-Phosphorous Compounds | | | r | | | | | | | | | r | |
| **Peroxides** | | | | | | | | | | | | | |
| Peroxides | | | | r | | | | | | | | | |
| **Sulfur Compounds** | | | | | | | | | | | | | |
| Thiols | | | ** | | | | | | | | | n | |

Note:
Class recommendations only for chemicals classes in which two or more chemicals have recommendations for a given material. Double asterisks (**) indicate a wide variation in ratings.

Source: <u>Guidelines for the Selection of Chemical Protective Clothing</u>; 3rd Edition; Feb. 1987; EPA, U.S. Coast Guard, Arthur D. Little, Inc., and Los Alamos National Laboratory.

## Compatibility Between Suit Materials and Chemicals (continued)

### QUALITATIVE DESCRIPTION OF RECOMMENDATIONS IN MATRIX *

Qualitative Ratings (columns); Test Data (rows)

| Quantity/ Resistance | Many/Excellent | Few/Excellent or Many/Good | Many/Fair or Few/Poor | Many/Poor | None |
|---|---|---|---|---|---|
| Many/Excellent | RR | RR | ** | ** | RR |
| Few/Excellent or Many/Good | rr | rr | ** | ** | rr |
| Many/Fair or Few/Poor | nn | nn | nn | nn | nn |
| Many/Poor | NN | NN | NN | NN | NN |
| None | R | r | n | N | No Recommendation |

* Recommendations obtained by computer algorithm. See Appendix H of Volume II for rationale.

** Recommendations for these combinations were determined on basis of technical judgment rather than computer algorithm

Single and double, upper and lower case "r's" and "n's" are used to convey the recommendations. Briefly, RR, R, rr, and r indicate various degrees of good resistance and NN, N, nn, and n indicate various degrees of poor chemical resistance. Double characters indicate that there are test data to support the recommendations, and single characters indicate that only qualitative information was available. Upper case characters indicate consensus and a relatively large amount of information, whereas lower case indicates a relatively small amount of information or inconsistencies.

Source: Guidelines for the Selection of Chemical Protective Clothing; 3rd Edition; Feb. 1987; EPA, U.S. Coast Guard, Arthur D. Little, Inc., and Los Alamos National Laboratory.

**Compatibility Between Suit Materials and Chemicals (continued)**

Multi-component materials are identified in two ways. Blends are indicated by a "+." For example, a blend of nitrile rubber and PVC is designated nitrile + PVC. Coated or laminated structures are indicated by a "/." For example, nitrile rubber coated polyester fabric is designated nitrile/polyester. By grouping several types and forms of clothing into one category, it is likely that in some cases particularly good or particularly poor items have gone unnoted since there can be significant differences in product quality between vendors. This is a compromise that must be accepted and recognized in summary compilations such as Matrices A and B. In general, however, a given material will exhibit the same performance relative to another material independent of whether the materials are free films or coatings and independent of source. For example, if a butyl rubber glove is more resistant than a nitrile rubber glove to a given chemical, then it is highly likely that butyl rubber gloves and clothing in both supported and unsupported form will be better barriers to that chemical than their nitrile counterparts. In other words, differences in performances between products of a given material will probably be small compared to performance differences between categories of materials. In using the matrices, it must be remembered that their purpose is to provide a starting point for CPC selections.

During the selection and eventual use of the CPC recommended in Matrices A and B, it is important to remember that:

1. The recommendations are based on the best information available. In some cases, however, this information is very limited.

2. The recommendations are a guide, not a guarantee.

3. The recommendations probably do not hold for extreme use conditions (e.g., high and low temperatures, long-term contact, high abrasion, etc.) nor do they consider the problems associated with reuse described in Chapter 6, Part F.

4. There may be certain products in each category that are better or poorer than the norm. Also, the quality of construction of even the "better" products can vary from batch to batch. In their present form, the matrices do not address quality issues. The assessment of quality and uniformity of quality can best be gained through field experience and, therefore, left as a task for the field personnel. It is possible that future *Guidelines* will be modified to include recommendations for specific products that are based on quality and field performance.

5. The "double" letter recommendations are based primarily on breakthrough time data; permeation rate data were given only secondary consideration.

Source: Guidelines for the Selection of Chemical Protective Clothing; 3rd Edition; Feb. 1987; EPA, U.S. Coast Guard, Arthur D. Little, Inc., and Los Alamos National Laboratory.

## Attachment 2.1-9

## Physical Characteristics of Chemical Protective Clothing

PHYSICAL CHARACTERISTICS OF CPC MATERIALS*

| Material (Designation in Matrices) | Abrasion Resistance | Cut Resistance | Flexibility | Heat Resistance | Ozone Resistance | Puncture Resistance | Tear Resistance | Relative Cost |
|---|---|---|---|---|---|---|---|---|
| Butyl Rubber (Butyl) | F | G | G | E | E | G | G | High |
| Chlorinated Polyethylene (CPE) | E | G | G | G | E | G | G | Low |
| Natural Rubber | E | E | E | F | P | E | E | Medium |
| Nitrile-Butadiene Rubber (NBR) | E | E | E | G | F | E | G | Medium |
| Neoprene | E | E | G | G | E | G | G | Medium |
| Nitrile Rubber (Nitrile) | E | E | E | G | F | E | G | Medium |
| Nitrile Rubber + Polyvinyl Chloride (Nitrile + PVC) | G | G | G | F | E | G | G | Medium |
| Polyethylene | F | F | G | F | F | P | F | Low |
| Polyurethane | E | G | E | G | G | G | G | High |
| Polyvinyl Alcohol (PVA) | F | F | P | G | E | F | G | Very High |
| Polyvinyl Chloride (PVC) | G | P | F | P | E | G | G | Low |
| Styrene-Butadiene Rubber (SBR) | E | G | G | G | F | F | F | Low |
| Viton | G | G | G | G | E | G | G | Very High |

------------------

*Ratings are subject to variation depending on formulation, thickness, and whether the material is supported by fabric. E-excellent; G-good; F-fair; P-poor

Source: Guidelines for the Selection of Chemical Protective Clothing; 3rd Edition; Feb. 1987; EPA, U.S. Coast Guard, Arthur D. Little, Inc., and Los Alamos National Laboratory.

## Attachment 2.1-10

## Sample Donning and Doffing Procedures

### Sample Donning Procedures[a,b,c]

1. Inspect the clothing and respiratory equipment before donning (see *Inspection*).
2. Adjust hard hat or headpiece if worn, to fit user's head.
3. Open back closure used to change air tank (if suit has one) before donning suit.
4. Standing or sitting, step into the legs of the suit; ensure proper placement of the feet within the suit; then gather the suit around the waist.
5. Put on chemical-resistant safety boots over the feet of the suit. Tape the leg cuff over the tops of the boots.
   - If additional chemical-resistant boots are required, put these on now.
   - Some one-piece suits have heavy-soled protective feet. With these suits, wear short, chemical-resistant safety boots inside the suit.
6. Put on air tanks and harness assembly of the SCBA. Don the facepiece and adjust it to be secure, but comfortable. Do *not* connect the breathing hose. Open valve on air tank.
7. Perform negative and positive respirator facepiece seal test procedures.
   - To conduct a negative-pressure test, close the inlet part with the palm of the hand or squeeze the breathing tube so it does not pass air, and gently inhale for about 10 seconds. Any inward rushing of air indicates a poor fit. Note that a leaking facepiece may be drawn tightly to the face to form a good seal, giving a false indication of adequate fit.
   - To conduct a positive-pressure test, gently exhale while covering the exhalation valve to ensure that a positive pressure can be built up. Failure to build a positive pressure indicates a poor fit.
8. Depending on type of suit:
   - Put on long-sleeved inner gloves (similar to surgical gloves).
   - Secure gloves to sleeves, for suits with detachable gloves (if not done prior to entering the suit).
   - Additional overgloves, worn over attached suit gloves, may be donned later.
9. Put sleeves of suit over arms as assistant pulls suit up and over the SCBA. Have assistant adjust suit around SCBA and shoulders to ensure unrestricted motion.
10. Put on hard hat, if needed.
11. Raise hood over head carefully so as not to disrupt face seal of SCBA mask. Adjust hood to give satisfactory comfort.
12. Begin to secure the suit by closing all fasteners on opening until there is only adequate room to connect the breathing hose. Secure all belts and/or adjustable leg, head, and waistbands.
13. Connect the breathing hose while opening the main valve.
14. Have assistant first ensure that wearer is breathing properly and then make final closure of the suit.
15. Have assistant check all closures.
16. 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.

[a]Source: Based on reference [9].

[b]Perform the procedures in the order indicated.

[c]When donning a suit, use a moderate amount of a powder to prevent chafing and to increase comfort. Powder will also reduce rubber binding.

### Sample Doffing Procedures[a]

**If sufficient air supply is available to allow appropriate decontamination before removal:**

1. Remove any extraneous or disposable clothing, boot covers, outer gloves, and tape.
2. Have assistant loosen and remove the wearer's safety shoes or boots.
3. 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.
4. Remove arms, one at a time, from suit. Once arms are free, have assistant lift the suit up and away from the SCBA backpack—avoiding any contact between the outside surface of the suit and the wearer's body—and lay the suit out flat behind the wearer. Leave internal gloves on, if any.
5. Sitting, if possible, remove both legs from the suit.
6. Follow procedure for doffing SCBA.
7. After suit is removed, remove internal gloves by rolling them off the hand, inside out.
8. Remove internal clothing and thoroughly cleanse the body.

**If the low-pressure warning alarm has sounded, signifying that approximately 5 minutes of air remain:**

1. Remove disposable clothing.
2. Quickly scrub and hose off, especially around the entrance/exit zipper.
3. Open the zipper enough to allow access to the regulator and breathing hose.
4. Immediately attach an appropriate canister to the breathing hose (the type and fittings should be predetermined). Although this provides some protection against any contamination still present, it voids the certification of the unit.
5. Follow Steps 1 through 8 of the regular doffing procedure above. Take extra care to avoid contaminating the assistant and wearer.

[a]Source = Based on reference [9].

Source: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, U.S. Government Printing Office, 1985.

## Standard Operating Safety Procedures

### STANDARD OPERATING SAFETY PRACTICES

Standard operating safety procedures should include safety precautions and operating practices, that all responding personnel should follow. These would include:

A. Personal Precautions

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated contaminated.
- Hands and face must be thoroughly washed upon leaving the work area.
- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.
- No facial hair which interferes with a satisfactory fit of the mask-to-face-seal is allowed on personnel required to wear respirators.
- Contact with contaminated or suspected contaminated surfaces should be avoided. Whenever possible, do not walk through puddles, leachate, discolored surfaces, kneel on ground, lean, sit, or place equipment on drums, containers, or the ground.
- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on response operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverages should be avoided, in the off-duty hours, during response operations.

B. Operations

- All personnel going on-site must be adequately trained and thoroughly briefed on anticipated hazards, equipment to be worn, safety practices to be followed, emergency procedures, and communications.
- Any required respiratory protection and chemical protective clothing must be worn by all personnel going into areas designated for wearing protective equipment.

Attachment 2.1-11

Standard Operating Safety Procedures
(continued)

- Personnel on-site must use the buddy system when wearing respiratory protection. As a minimum, two other persons, suitably equipped, are required as safety backup during initial entries.

- Visual contact must be maintained between pairs on-site and safety personnel. Entry team members should remain close together to assist each other during emergencies.

- During continual operations, on-site workers act as safety backup to each other. Off-site personnel provide emergency assistance.

- Personnel should practice unfamiliar operations prior to doing the actual procedure.

- Entrance and exit locations must be designated and emergency escape routes delineated. Warning signals for site evacuation must be established.

- Communications using radios, hand signals, signs, or other means must be maintained between initial entry members at all times. Emergency communications should be prearranged in case of radio failure, necessity for evacuation of site, or other reasons.

- Wind indicators visible to all personnel should be strategically located throughout the site.

- Personnel and equipment in the contaminated area should be minimized, consistent with effective site operations.

Source: Standard Operating Safety Guides, EPA, Office of Emergency and Remedial Response, 1988.