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I. INTRODUCTION

A. The purpose of chemical protective clothing and equipment is to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered during hazardous materials operations. During chemical operations, it is not always apparent when exposure occurs. Many chemicals pose invisible hazards and offer no warning properties.

B. These guidelines describe the various types of clothing that are appropriate for use in various chemical operations, and provides recommendations in their selection and use. The final paragraph discusses heat stress and other key physiological factors that must be considered in connection with protective clothing use.

C. It is important that protective clothing users realize that no single combination of protective equipment and clothing is capable of protecting you against all hazards. Thus protective clothing should be used in conjunction with other protective methods. For example, engineering or administrative controls to limit chemical contact with personnel should always be considered as an alternative measure for preventing chemical exposure. The use of protective clothing can itself create significant wearer hazards, such as heat stress, physical and psychological stress, in addition to impaired vision, mobility, and communication. In general, the greater the level of chemical protective clothing, the greater the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Overprotection as well as under-protection can be hazardous and should be avoided.

II. DESCRIPTIONS

A. Protective Clothing Applications

1. Protective clothing must be worn whenever the wearer faces potential hazards arising from chemical exposure. Some examples include:

   - Emergency response;
   - Chemical manufacturing and process industries;
   - Hazardous waste site cleanup and disposal;
   - Asbestos removal and other particulate operations; and
   - Agricultural application of pesticides.

2. Within each application, there are several operations which require chemical protective clothing. For example, in emergency response, the following activities dictate chemical protective clothing use:

   - **Site Survey:** The initial investigation of a hazardous materials incident; these situations are usually characterized by a large degree of uncertainty and mandate the highest levels of protection.
   - **Rescue:** Entering a hazardous materials area for the purpose of removing an exposure victim; special considerations must be given to how the selected protective clothing may affect the ability of the wearer to carry out rescue and to the contamination of the victim.
   - **Spill Mitigation**: Entering a hazardous materials area to prevent a potential spill or to reduce the hazards from an existing spill (i.e., applying a chlorine kit on railroad tank car). Protective clothing must accommodate the required tasks without sacrificing adequate protection.

- **Emergency Monitoring:** Outfitting personnel in protective clothing for the primary purpose of observing a hazardous materials incident without entry into the spill site. This may be applied to monitoring contract activity for spill cleanup.
- **Decontamination:** Applying decontamination procedures to personnel or equipment leaving the site; in general a lower level of protective clothing is used by personnel involved in decontamination.

B. **The Clothing Ensemble**. The approach in selecting personal protective clothing must encompass an "ensemble" of clothing and equipment items which are easily integrated to provide both an appropriate level of protection and still allow one to carry out activities involving chemicals. In many cases, simple protective clothing by itself may be sufficient to prevent chemical exposure, such as wearing gloves in combination with a splash apron and faceshield (or safety goggles).

1. The following is a checklist of components that may form the chemical protective ensemble:

   - Protective clothing (suit, coveralls, hoods, gloves, boots);
   - Respiratory equipment (SCBA, combination SCBA/SAR, air purifying respirators);
   - Cooling system (ice vest, air circulation, water circulation);
   - Communications device;
   - Head protection;
   - Eye protection;
   - Ear protection;
   - Inner garment; and
   - Outer protection (overgloves, overboots, flashcover).

2. Factors that affect the selection of ensemble components include:

   - How each item accommodates the integration of other ensemble components. Some ensemble components may be incompatible due to how they are worn (e.g., some SCBA's may not fit within a particular chemical protective suit or allow acceptable mobility when worn).
   - The ease of interfacing ensemble components without sacrificing required performance (e.g. a poorly fitting overglove that greatly reduces wearer dexterity).
   - Limiting the number of equipment items to reduce donning time and complexity (e.g. some communications devices are built into SCBA's which as a unit are NIOSH certified).

C. **Level of Protection**

1. Table VIII:1-1 lists ensemble components based on the widely used *EPA Levels of Protection: Levels A, B, C, and D.* These lists can be used as the starting point for ensemble creation; however, each ensemble must be tailored to the specific situation in order to provide the most appropriate level of protection. For example, if an emergency response activity involves a highly contaminated area or if the potential of contamination is high, it may be advisable to wear a disposable covering such as Tyvek coveralls or PVC splash suits, over the protective ensemble.

TABLE VIII:1-1. EPA LEVELS OF PROTECTION

LEVEL A:
Vapor protective suit (meets NFPA 1991) Pressure-demand, full-face SCBA

Inner chemical-resistant gloves, chemical-resistant safety boots, two-way radio communication OPTIONAL: Cooling system, outer gloves, hard hat *Protection Provided:* Highest available level of respiratory, skin, and eye protection from solid, liquid and gaseous chemicals. *Used When:* The chemical(s) have been identified and have high level of hazards to respiratory system, skin and eyes. Substances are present with known or suspected skin toxicity or carcinogenity. Operations must be conducted in confined or poorly ventilated areas. *Limitations:* Protective clothing must resist permeation by the chemical or mixtures present. Ensemble items must allow integration without loss of performance.
LEVEL B: Liquid splash-protective suit (meets NFPA 1992) Pressure-demand, full-facepiece SCBA Inner chemical-resistant gloves, chemical-resistant safety boots, two-way radio communications Hard hat. OPTIONAL: Cooling system, outer gloves *Protection Provided:* Provides same level of respiratory protection as Level A, but less skin protection. Liquid splash protection, but no protection against chemical vapors or gases. *Used When:* The chemical(s) have been identified but do not require a high level of skin protection. Initial site surveys are required until higher levels of hazards are identified. The primary hazards associated with site entry are from liquid and not vapor contact. *Limitations:* Protective clothing items must resist penetration by the chemicals or mixtures present. Ensemble items must allow integration without loss of performance.
LEVEL C: Support Function Protective Garment (meets NFPA 1993) Full-facepiece, air-purifying, canister-equipped respirator Chemical resistant gloves and safety boots Two-way communications system, hard hat OPTIONAL: Faceshield, escape SCBA *Protection Provided:* The same level of skin protection as Level B, but a lower level of respiratory protection. Liquid splash protection but no protection to chemical vapors or gases. *Used When:* Contact with site chemical(s) will not affect the skin. Air contaminants

have been identified and concentrations measured. A canister is available which can remove the contaminant. The site and its hazards have been completely characterized. *Limitations:* Protective clothing items must resist penetration by the chemical or mixtures present. Chemical airborne concentration must be less than IDLH levels. The atmosphere must contain at least 19.5% oxygen. **Not Acceptable for Chemical Emergency Response**
LEVEL D: Coveralls, safety boots/shoes, safety glasses or chemical splash goggles OPTIONAL: Gloves, escape SCBA, face-shield *Protection Provided:* No respiratory protection, minimal skin protection. *Used When:* The atmosphere contains no known hazard. Work functions preclude splashes, immersion, potential for inhalation, or direct contact with hazard chemicals. *Limitations:* This level should not be worn in the Hot Zone. The atmosphere must contain at least 19.5% oxygen. **Not Acceptable for Chemical Emergency Response**

2. The type of equipment used and the overall level of protection should be reevaluated periodically as the amount of information about the chemical situation or process increases, and when workers are required to perform different tasks. Personnel should upgrade or downgrade their level of protection only with concurrence with the site supervisor, safety officer, or plant industrial hygienist.

3. The recommendations in Table VIII:1-1 serve only as guidelines. It is important for you to realize that selecting items by how they are designed or configured alone is not sufficient to ensure adequate protection. In other words, just having the right components to form an ensemble is not enough. The EPA levels of protection do not define what performance the selected clothing or equipment must offer. Many of these considerations are described in the "limiting criteria" column of Table VIII: 1-1. Additional factors relevant to the various clothing and equipment items are described in subsequent Paragraphs.

D. **Ensemble Selection Factors**

1. **Chemical Hazards**. Chemicals present a variety of hazards such as toxicity, corrosiveness, flammability, reactivity, and oxygen deficiency. Depending on the chemicals present, any combination of hazards may exist.

2. **Physical Environment**. Chemical exposure can happen anywhere: in industrial settings, on the highways, or in residential areas. It may occur either indoors or outdoors; the environment may be extremely hot, cold, or moderate; the exposure site may be relatively uncluttered or rugged, presenting a number of physical hazards; chemical handling activities may involve entering confined spaces, heavy lifting, climbing a ladder, or crawling on the ground. The choice of ensemble components must account for these conditions.

3. **Duration of Exposure**. The protective qualities of ensemble components may be limited to certain exposure levels (e.g. material chemical resistance, air supply). The decision for ensemble use time must be made assuming the worst case exposure so that safety margins can be applied to increase the protection available to the worker.

4. **Protective Clothing or Equipment Available**. Hopefully, an array of different clothing or equipment is available to workers to meet all intended applications. Reliance on one particular clothing or equipment item may severely limit a facility's ability to handle a broad range of chemical exposures. In its acquisition of equipment and clothing, the safety department or other responsible authority should attempt to provide a high degree of flexibility while choosing protective clothing and equipment that is easily integrated and provides protection against each conceivable hazard.

E. **Classification of Protective Clothing**

1. Personal protective clothing includes the following:

   - Fully encapsulating suits;
   - Nonencapsulating suits;
   - Gloves, boots, and hoods;
   - Firefighter's protective clothing;
   - Proximity, or approach clothing;
   - Blast or fragmentation suits; and
   - Radiation-protective suits.

2. *Firefighter turnout clothing, proximity gear, blast suits, and radiation suits by themselves are not acceptable for providing adequate protection from hazardous chemicals.*

3. Table VIII:1-2 describes various types of protection clothing available, details the type of protection they offer, and lists factors to consider in their selection and use.

TABLE VIII:1-2. TYPES OF PROTECTIVE CLOTHING FOR FULL BODY PROTECTION

Description	Type of Protection	Use Considerations
Fully encapsulating suit One-piece garment. Boots and gloves may	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

be integral, attached and replaceable, or separate.		conjunction with a closed-circuit SCBA; a cooling garment may be needed. Impairs worker mobility, vision, and communication.
Nonencapsulating 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. May contribute to heat stress in wearer. Tape-seal connections between pant cuffs and boots and between gloves and sleeves.
Aprons, leggings, and sleeve protectors Fully sleeved and gloved apron. Separate coverings for arms and legs. Commonly worn over nonencapsulating suit.	Provides additional splash protection of chest, forearms, and legs.	Whenever possible, should be used over a nonencapsulating suit to minimize potential heat stress. Useful for sampling, labeling, and analysis operations. Should be used only when there is a low probability of total body contact with contaminants.
Firefighters' protective clothing Gloves, helmet, running or bunker coat, running or bunker pants (NFPA No. 1971, 1972, 1973, and boots (1974).	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 consists of an outer shell, an inner liner and a vapor barrier with a minimum water penetration of 25 lb/in^2 (1.8 kg/cm^2) to prevent passage of hot water.	Decontamination is difficult. 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	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

aluminized nylon or cotton fabric. Normally worn over other protective clothing, firefighters' bunker gear, or flame-retardant coveralls.		cooling garment may be needed. Impairs worker mobility, vision, and communication.
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 for hearing protection.
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

F. **Classification of Chemical Protective Clothing**. Table VIII:1-3 provides a listing of clothing classifications. Clothing can be classified by design, performance, and service life.

TABLE VIII:1-3. CLASSIFICATION OF CHEMICAL PROTECTIVE CLOTHING

By Design	By Performance	By Service Life
gloves boots aprons, jackets, coveralls, full body suits	particulate protection liquid-splash protection vapor protection	single use limited use reusable

1. **Design**. Categorizing clothing by design is mainly a means for describing what areas of the body the clothing item is intended to protect.

   In emergency response, hazardous waste site cleanup, and dangerous chemical operations, the only acceptable types of protective clothing include fully or totally encapsulating suits and nonencapsulating or "splash" suits plus accessory clothing items such as chemically resistant gloves or boots. These descriptions apply to how the clothing is designed and not to its performance.

2. **Performance**. The National Fire Protection Association (NFPA) has classified suits by their performance as:

a. Vapor-protective suits (NFPA Standard 1991) provide "gas-tight" integrity and are intended for response situations where no chemical contact is permissible. This type of suit would be equivalent to the clothing required in EPA's Level A.

b. Liquid splash-protective suits (NFPA Standard 1992) offer protection against liquid chemicals in the form of splashes, but not against continuous liquid contact or chemical vapors or gases. Essentially, the type of clothing would meet the EPA Level B needs. It is important to note, however, that by wearing liquid splash-protective clothing, the wearer accepts exposure to chemical vapors or gases because this clothing does not offer gas-tight performance. The use of duct tape to seal clothing interfaces does not provide the type of wearer encapsulation necessary for protection against vapors or gases.

c. Support function protective garments (NFPA Standard 1993) must also provide liquid splash protection but offer limited physical protection. These garments may comprise several separate protective clothing components (i.e., coveralls, hoods, gloves, and boots). They are intended for use in nonemergency, nonflammable situations where the chemical hazards have been completely characterized. Examples of support functions include proximity to chemical processes, decontamination, hazardous waste clean-up, and training. Support function protective garments should not be used in chemical emergency response or in situations where chemical hazards remain uncharacterized.

d. These NFPA standards define minimum performance requirements for the manufacture of chemical protective suits. Each standard requires rigorous testing of the suit and the materials that comprise the suit in terms of overall protection, chemical resistance, and physical properties. Suits that are found compliant by an independent certification and testing organization may be labeled by the manufacturer as meeting the requirements of the respective NFPA standard. Manufacturers also have to supply documentation showing all test results and characteristics of their protective suits.

e. Protective clothing should completely cover both the wearer and his or her breathing apparatus. In general, respiratory protective equipment is not designed to resist chemical contamination. Level A protection (vapor-protective suits) require this configuration. Level B ensembles may be configured either with the SCBA on the outside or inside. However, it is strongly recommended that the wearer's respiratory equipment be worn inside the ensemble to prevent its failure and to reduce decontamination problems. Level C ensembles use cartridge or canister type respirators which are generally worn outside the clothing.

3. **Service Life**

a. Clothing item service life is an end user decision depending on the costs and risks associated with clothing decontamination and reuse. For example, a Saranex/Tyvek garment may be designed to be a coverall (covering the wearer's torso, arms, and legs) intended for liquid splash protection, which is disposable after a single use.

b. Protective clothing may be labeled as:

- Reusable, for multiple wearings; or
- Disposable, for one-time use.

The distinctions between these types of clothing are both vague and complicated. Disposable clothing is generally lightweight and inexpensive. Reusable clothing is often more rugged and costly. Nevertheless, extensive contamination of any garment may render it disposable. The basis of this classification really depends on the costs involved in purchasing, maintaining, and reusing protective clothing versus the alternative of disposal following exposure. If an end user can anticipate obtaining several uses out of a garment while still maintaining adequate protection from that garment at lower cost than its disposal, the suit becomes reusable. Yet, the key assumption in this determination is the viability of the garment following exposure. This issue is further discussed in the Paragraph on decontamination.

III.

IV. PROTECTIVE CLOTHING SELECTION FACTORS

A. **Clothing Design**. Manufacturers sell clothing in a variety of styles and configurations.

1. **Design Considerations**

- Clothing configuration;
- Components and options;
- Sizes;
- Ease of donning and doffing;
- Clothing construction;
- Accommodation of other selected ensemble equipment;
- Comfort; and
- Restriction of mobility.

B. **Material Chemical Resistance**. Ideally, the chosen material(s) must resist permeation, degradation, and penetration by the respective chemicals.

1. **Permeation** is the process by which a chemical dissolves in or moves through a material on a molecular basis. In most cases, there will be no visible evidence of chemicals permeating a material.

Permeation breakthrough time is the most common result used to assess material chemical compatibility. The rate of permeation is a function of several factors such as chemical concentration, material thickness, humidity, temperature, and pressure. Most material testing is done with 100% chemical over an extended exposure period. The time it takes chemical to permeate through the material is the breakthrough time. An acceptable material is one where the breakthrough time exceeds the expected period of garment use. However, temperature and pressure effects may enhance permeation and reduce the magnitude of this safety factor. For example, small increases in ambient temperature can significantly reduce breakthrough time and the protective barrier properties of a protective clothing material.

2. **Degradation** involves physical changes in a material as the result of a chemical exposure, use, or ambient conditions (e.g. sunlight). The most common observations of material degradation are discoloration, swelling, loss of physical strength, or deterioration.

3. **Penetration** is the movement of chemicals through zippers, seams, or imperfections in a protective clothing material.

   It is important to note that no material protects against all chemicals and combinations of chemicals, and that no currently available material is an effective barrier to any prolonged chemical exposure.

4. Sources of information include:

   - *Guidelines for the Selection of Chemical Protective Clothing,* 3rd Edition. This reference provides a matrix of clothing material recommendations for approximately 500 chemicals based on an evaluation of chemical resistance test data, vendor literature, and raw material suppliers. The major limitation for these guidelines are their presentation of recommendations by generic material class. Numerous test results have shown that similar materials from different manufacturers may give widely different performance. That is to say manufacturer A's butyl rubber glove may protect against chemical X, but a butyl glove made by manufacturer B may not.

   - *Quick Selection Guide to Chemical Protective Clothing.* Pocket size guide that provides chemical resistance data and recommendations for 11 generic materials against over 400 chemicals. The guide is color-coded by material-chemical recommendation. As with the "Guidelines..." above, the major limitation of this reference is its dependence on generic data.

   - Vendor data or recommendations. The best source of current information on material compatibility should be available from the manufacturer of the selected clothing. Many vendors supply charts which show actual test data or their own recommendations for specific chemicals. However, *unless vendor data or the recommendations are well documented, end users must approach this information with caution.* Material recommendations must be based on data obtained from tests performed to standard ASTM methods. Simple ratings of "poor," "good," or "excellent" give no indication of how the material may perform against various chemicals.

5. Mixtures of chemicals can be significantly more aggressive towards protective clothing materials than any single chemical alone. One permeating chemical may pull another with it through the material. Very little data is available for chemical mixtures. Other situations may involve unidentified substances. In both the case of mixtures and unknowns, serious consideration must be given to deciding which protective clothing is selected. If clothing must be used without test data, garments with materials having the broadest chemical resistance should be worn, i.e. materials

which demonstrate the best chemical resistance against the widest range of chemicals.

C. **Physical Properties**

1. As with chemical resistance, manufacturer materials offer wide ranges of physical qualities in terms of strength, resistance to physical hazards, and operation in extreme environmental conditions. Comprehensive manufacturing standards such as the NFPA Standards set specific limits on these material properties, but only for limited applications, i.e. emergency response.

2. End users in other applications may assess material physical properties by posing the following questions:

   - Does the material have sufficient strength to withstand the physical strength of the tasks at hand?
   - Will the material resist tears, punctures, cuts, and abrasions?
   - Will the material withstand repeated use after contamination and decontamination?
   - Is the material flexible or pliable enough to allow end users to perform needed tasks?
   - Will the material maintain its protective integrity and flexibility under hot and cold extremes?
   - Is the material flame-resistant or self-extinguishing (if these hazards are present)?
   - Are garment seams in the clothing constructed so they provide the same physical integrity as the garment material?

D. **Ease of Determination**. The degree of difficulty in decontaminating protective clothing may dictate whether disposable or reusable clothing is used, or a combination of both.

E. **Cost**. Protective clothing end users must endeavor to obtain the broadest protective equipment they can buy with available resources to meet their specific application.

F. **Chemical Protective Clothing Standards**. Protective clothing buyers may wish to specify clothing that meets specific standards, such as 1910.120 or the NFPA standards (see Paragraph on classification by performance). The NFPA Standards do not apply to all forms of protective clothing and applications.

V. GENERAL GUIDELINES

A. **Decide if the Clothing Item is Intended to Provide Vapor, Liquid-Splash, or Particulate Protection**

1. Vapor protective suits also provide liquid splash and particulate protection. Liquid splash protective garments also provide particulate protection. Many garments may be labeled as totally encapsulating but do not provide gas-tight integrity due to inadequate seams or closures. Gas-tight integrity can only be determined by

performing a pressure or inflation test and a leak detection test of the respective protective suit. This test involves:

- Closing off suit exhalation valves;
- Inflating the suit to a prespecified pressure; and
- Observing whether the suit holds the above pressure for a designated period.

ASTM Standard Practice F1052 (1987 Edition) offers a procedure for conducting this test.

B.

1. Splash suits must still cover the entire body when combined with the respirator, gloves, and boots. Applying duct tape to a splash suit does not make it protect against vapors. Particulate protective suits may not need to cover the entire body, depending on the hazards posed by the particulate. In general, gloves, boots and some form of face protection are required. Clothing items may only be needed to cover a limited area of the body such as gloves on hands. The nature of the hazards and the expected exposure will determine if clothing should provide partial or full body protection.

C. **Determine If the Clothing Item Provides Full Body Protection**

1. Vapor-protective or totally encapsulating suit will meet this requirement by passing gas-tight integrity tests.

2. Liquid splash-protective suits are generally sold incomplete (i.e. fewer gloves and boots).

3. Missing clothing items must be obtained separately and match or exceed the performance of the garment.

4. Buying a PVC glove for a PVC splash suit does not mean that you obtain the same level of protection. This determination must be made by comparing chemical resistance data.

D. **Evaluate Manufacturer Chemical Resistance Data Provided With the Clothing**

1. Manufacturers of vapor-protective suits should provide permeation resistance data for their products, while liquid and particulate penetration resistance data should accompany liquid splash and particulate protective garments respectively. Ideally data should be provided for every primary material in the suit or clothing item. For suits, this includes the garment, visor, gloves, boots, and seams.

2. Permeation data should include the following:

   - Chemical name;
   - Breakthrough time (shows how soon the chemical permeates);

- Permeation rate (shows the rate that the chemical comes through);
- System sensitivity (allows comparison of test results from different laboratories); and
- A citation that the data was obtained in accordance with ASTM Standard Test Method F739-85.

3. If no data are provided or if the data lack any one of the above items, the manufacturer should be asked to supply the missing data. Manufacturers that provide only numerical or qualitative ratings must support their recommendations with complete test data.

4. Liquid penetration data should include a pass or fail determination for each chemical listed, and a citation that testing was conducted in accordance with ASTM Standard Test Method F903-86. Protective suits which are certified to NFPA 1991 or NFPA 1992 will meet all of the above requirements.

5. Particulate penetration data should show some measure of material efficiency in preventing particulate penetration in terms of particulate type or size and percentage held out. Unfortunately, no standard tests are available in this area and end users may have little basis for company products.

6. Suit materials which show no breakthrough or no penetration to a large number of chemicals are likely to have a broad range of chemical resistance. (Breakthrough times greater than one hour are usually considered to be an indication of acceptable performance.) Manufacturers should provide data on the ASTM Standard Guide F1001-86 chemicals. These 15 liquid and 6 gaseous chemicals listed in Table VIII:1-4 below represent a cross-section of different chemical classes and challenges for protective clothing materials. Manufacturers should also provide test data on other chemicals as well. If there are specific chemicals within your operating area that have not been tested, ask the manufacturer for test data on these chemicals.

TABLE VIII:1-4. RECOMMENDED CHEMICALS TO EVALUATE THE PERFORMANCE OF PROTECTIVE CLOTHING MATERIALS

Chemical	Class
Acetone	Ketone
Acetonitrile	Nitrile
Ammonia	Strong base (gas)
1,3-Butadiene	Olefin (gas)
Carbon Disulfide	Sulfur-containing organic
Chlorine	Inorganic gas
Dichloromethane	Chlorinated hydrocarbon
Diethylamine	Amine
Dimethyl formamide	Amide
Ethyl Acetate	Ester
Ethyl Oxide	Oxygen heterocyclic gas

Hexane	Aliphatic hydrocarbon
Hydrogen Chloride	Acid gas
Methanol	Alcohol
Methyl Chloride	Chlorinated hydrocarbon (gas)
Nitrobenzene	Nitrogen-containing organic
Sodium Hydroxide	Inorganic base
Sulfuric Acid	Inorganic acid
Tetrachloroethylene	Chlorinated hydrocarbon
Tetrahydrofuran	Oxygen heterocyclic
Toluene	Aromatic hydrocarbon

E. **Obtain and Examine the Manufacturer's Instruction or Technical Manual**

1. This manual should document all the features of the clothing, particularly suits, and describe what material(s) are used in its construction. It should cite specific limitations for the clothing and what restrictions apply to its use. Procedures and recommendations should be supplied for at least the following:

   - Donning and doffing;
   - Inspection, maintenance, and storage;
   - Decontamination; and
   - Use.

   The manufacturer's instructions should be thorough enough to allow the end users to wear and use the clothing without a large number of questions.

F. **Obtain and Inspect Sample Clothing Item Garments.** Examine the quality of clothing construction and other features that will impact its wearing. The questions listed under "Protective Clothing Selection Factors, Clothing Design" should be considered. If possible, representative clothing items should be obtained in advance and inspected prior to purchase, and discussed with someone who has experience in their use. It is also helpful to try out representative garments prior to purchase by suiting personnel in the garment and having them run through exercises to simulate expected activities.

G. **Field Selection of Chemical Protective Clothing**

1. Even when end users have gone through a very careful selection process, a number of situations will arise when no information is available to judge whether their protective clothing will provide adequate protection. These situations include:

   - Chemicals that have not been tested with the garment materials;
   - Mixtures of two or more different chemicals;
   - Chemicals that cannot be readily identified;
   - Extreme environmental conditions (hot temperatures); and
   - Lack of data in all clothing components (e.g. seams, visors).

2. Testing material specimens using newly developed field test kits may offer one means for making an on-site clothing selection. A portable test kit has been developed by the EPA using a simple weight loss method that allows field qualification of protective clothing materials within one hour. Use of this kit may overcome the absence of data and provide additional criteria for clothing selection.

3. *Selection of chemical protective clothing is a complex task and should be performed by personnel with both extensive training and experience.*

   Under all conditions, clothing should be selected by evaluating its performance characteristics against the requirements and limitations imposed by the application.

VI. MANAGEMENT PROGRAM

A. Written Management Program

1. A written Chemical Protective Clothing Management Program should be established by all end users who routinely select and use protective clothing. Reference should be made to 1910.120 for those covered.

   The written management program should include policy statements, procedures, and guidelines. Copies should be made available to all personnel who may use protective clothing in the course of their duties or job. Technical data on clothing, maintenance manuals, relevant regulations, and other essential information should also be made available.

2. The two basic objectives of any management program should be to protect the wearer from safety and health hazards, and to prevent injury to the wearer from incorrect use and/or malfunction of the chemical protective clothing. To accomplish these goals, a comprehensive management program should include: hazard identification; medical monitoring; environmental surveillance; selection, use, maintenance, and decontamination of chemical protective clothing; and training.

B. **Program Review and Evaluation.** The management program should be reviewed at least annually. Elements which should be considered in the review include:

- The number of person-hours that personnel wear various forms of chemical protective clothing and other equipment;
- Accident and illness experience;
- Levels of exposure;
- Adequacy of equipment selection;
- Adequacy of the operational guidelines;
- Adequacy of decontamination, cleaning, inspection, maintenance, and storage programs;
- Adequacy and effectiveness of training and fitting programs;
- Coordination with overall safety and health program;
- The degree of fulfillment of program objectives;
- The adequacy of program records;
- Recommendations for program improvement and modification; and
- Program costs.

The results of the program evaluation should be made available to all end users and presented to top management so that program changes may be implemented.

VII.

A. **Types of Standard Operating Procedures.** Personal protective clothing and equipment can offer a high degree of protection only if it is used properly. Standard Operating Procedures (SOP's) should be established for all workers involved in handling hazardous chemicals. Areas that should be addressed include:

- Selection of protective ensemble components;
- Protective clothing and equipment donning, doffing, and use;
- Decontamination procedures;
- Inspection, storage, and maintenance of protective clothing/equipment; and
- Training.

B. **Selection of Protective Clothing Components**

0. Protective clothing and equipment SOP's must take into consideration the factors presented in the Clothing Ensemble and Protective Clothing Applications Paragraphs of this chapter. All clothing and equipment selections should provide a decision tree that relates chemical hazards and information to levels of protection and performance needed.

1. Responsibility in selecting appropriate protective clothing should be vested in a specific individual who is trained in both chemical hazards and protective clothing use such as a safety officer or industrial hygienist. Only chemical protective suits labeled as compliant with the appropriate performance requirements should be used. In cases where the chemical hazards are known in advance or encountered routinely, clothing selection should be predetermined. That is, specific clothing items should be identified in specific chemical operations without the opportunity for individual selection of other clothing items.

VIII. CLOTHING DONNING, DOFFING, AND USE

The procedures below are given for vapor protective or liquid-splash protective suit ensembles and should be included in the training program.

A. **Donning the Ensemble**

0. A routine should be established and practiced periodically for donning the various ensemble configurations that a facility or team may use. Assistance should be provided for donning and doffing since these operations are difficult to perform alone, and solo efforts may increase the possibility of ensemble damage.

1. Table VIII:1-5 below lists sample procedures for donning a totally encapsulating suit/SCBA ensemble. These procedures should be modified depending on the suit and accessory equipment used. The procedures assume the wearer has previous training in respirator use and decontamination procedures.

2. Once the equipment has been donned, its fit should be evaluated. If the clothing is too small, it will restrict movement, increase the likelihood of tearing the suit

material, and accelerate wearer fatigue. If the clothing is too large, the possibility of snagging the material is increased, and the dexterity and coordination of the wearer may be compromised. In either case, the wearer should be recalled and better-fitting clothing provided.

TABLE VIII:1-5. SAMPLE DONNING PROCEDURES

1. Inspect clothing and respiratory equipment before donning (see Paragraph on 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 safety 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 tank 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.

B. **Doffing an Ensemble**

0. Exact procedures for removing a totally encapsulating suit/SCBA ensemble must be established and followed in order to prevent contaminant migration from the response scene and transfer of contaminants to the wearer's body, the doffing assistant, and others.

1. Sample doffing procedures are provided in Table VIII:1-6 below. These procedures should be performed only after decontamination of the suited end user. They require a suitably attired assistance. Throughout the procedures, both wearer and assistant should avoid any direct contact with the outside surface of the suit.

TABLE VIII:1-6. SAMPLE DOFFING PROCEDURES

If sufficient air supply is available to allow appropriate decontamination before removal:
0. Remove any extraneous or disposable clothing, boot covers, outer gloves, and tape.
1. Have assistant loosen and remove the wearer's safety shoes or boots.
2. 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.
3. 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.
4. Sitting, if possible, remove both legs from the suit.
5. Follow procedure for doffing SCBA.
6. After suit is removed, remove internal gloves by rolling them off the hand, inside out.
7. Remove internal clothing and thoroughly cleanse the body.
If the low-pressure warning alarm has sounded, signifying that approximately 5 minutes of air remain:
8. Remove disposable clothing.
9. Quickly scrub and hose off, especially around the entrance/exit zipper.
10. Open the zipper enough to allow access to the regulator and breathing hose.
11. 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.
12. Follow Steps 1 through 8 of the regular doffing procedure above. Take

extra care to avoid contaminating the assistant and the wearer.

C. **User Monitoring and Training**

0. The wearer must understand all aspects of clothing/equipment operation and their limitations; this is especially important for fully encapsulating ensembles where misuse could potentially result in suffocation. During protective clothing use, end users should be encouraged to report any perceived problems or difficulties to their supervisor. These malfunctions include, but are not limited to:

   - Degradation of the protection ensemble;
   - Perception of odors;
   - Skin irritation;
   - Unusual residues on clothing material;
   - Discomfort;
   - Resistance to breathing;
   - Fatigue due to respirator use;
   - Interference with vision or communication;
   - Restriction of movement; and
   - Physiological responses such as rapid pulse, nausea, or chest pain.
1. Before end users undertake any activity in their chemical protective ensembles, the anticipated duration of use should be established. Several factors limit the length of a mission, including:

   - Air supply consumption as affected by wearer work rate, fitness, body size, and breathing patterns;
   - Suit ensemble permeation, degradation, and penetration by chemical contaminants, including expected leakage through suit or respirator exhaust valves (ensemble protection factor);
   - Ambient temperature as it influences material chemical resistance and flexibility, suit and respirator exhaust valve performance, and wearer heat stress; and
   - Coolant supply (if necessary).

IX. **Decontamination Procedures**

A. **Definition of Types**

0. Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel and equipment. This process is critical to health and safety at hazardous material response sites. Decontamination protects end users from hazardous substances that may contaminate and eventually permeate the protective clothing, respiratory equipment, tools, vehicles, and other equipment used in the vicinity of the chemical hazard; it protects all plant or site personnel by minimizing the transfer of harmful materials into clean areas; it helps prevent mixing of incompatible chemicals; and it protects the community by preventing uncontrolled transportation of contaminants from the site.

1. There are two types of decontamination:

   - **Gross decontamination:** To allow end user to safely exit or doff the chemical protective clothing.

- **Decontamination** for reuse of chemical protective clothing.

B. **Prevention of Contamination**. The first step in decontamination is to establish Standard Operating Procedures that minimize contact with chemicals and thus the potential for contamination. For example:

- Stress work practices that minimize contact with hazardous substances (e.g. do not walk through areas of obvious contamination, do not directly touch potentially hazardous substances).
- Use remote sampling, handling, and container-opening techniques (e.g. drum grapples, pneumatic impact wrenches).
- Protect monitoring and sampling instruments by bagging. Make openings in the bags for sample ports and sensors that must contact site materials.
- Wear disposable outer garments and use disposable equipment where appropriate.
- Cover equipment and tools with a strippable coating that can be removed during decontamination.
- Encase the source of contaminants, e.g. with plastic sheeting or overpacks.
- Ensure all closures and ensemble component interfaces are completely secured; and that no open pockets that could serve to collect contaminant are present.

C. **Types of Contamination**

0. **Surface Contaminants**. Surface contaminants may be easy to detect and remove.

1. **Permeated Contaminants**. Contaminants that have permeated a material are difficult or impossible to detect and remove. If contaminants that have permeated a material are not removed by decontamination, they may continue to permeate the material where they can cause an unexpected exposure.

   Four major factors affect the extent of permeation:

   - **Contact time.** The longer a contaminant is in contact with an object, the greater the probability and extent of permeation. For this reason, minimizing contact time is one of the most important objectives of a decontamination program.
   - **Concentration.** Molecules flow from areas of high concentration to areas of low concentration. As concentrations of chemicals increase, the potential for permeation of personal protective clothing increases.
   - **Temperature.** An increase in temperature generally increases the permeation rate of contaminants.
   - **Physical state of chemicals.** As a rule, gases, vapors, and low-viscosity liquids tend to permeate more readily than high-viscosity liquids or solids.

D. **Decontamination Methods**

0. Decontamination methods either (1) physically remove contaminants; (2) inactivate contaminants by chemical detoxification or disinfection/sterilization; or (3) remove contaminants by a combination of both physical and chemical means.

1. In general, gross decontamination is accomplished using detergents (surfactants) in water combined with a physical scrubbing action. This process will remove most forms of surface contamination including dusts, many inorganic chemicals, and some organic chemicals. Soapy water scrubbing of protective suits may not be effective in removing oily or tacky organic substances (e.g. PCB's in transformer oil).

Furthermore, this form of decontamination is unlikely to remove any contamination that has permeated or penetrated the suit materials. Using organic solvents such as petroleum distillates may allow easier removal of heavy organic contamination but may result in other problems, including:

- Permeation into clothing components, pulling the contaminant with it;
- Spreading localized contaminant into other areas of the clothing; and
- Generating large volumes of contaminated solvents that require disposal.

2. One promising method for removing internal or matrix contamination is the forced circulation of heated air over clothing items for extended periods of time. This allows many organic chemicals to migrate out of the materials and evaporate into the heated air. The process does require, however, that the contaminating chemicals be volatile. Additionally, low level heat may accelerate the removal of plasticizer from garment materials and affect the adhesives involved in garment seams.

3. Unfortunately, both manufacturers and protective clothing authorities provide few specific recommendations for decontamination. There is no definitive list with specific methods recommended for specific chemicals and materials. Much depends on the individual chemical-material combination involved.

E. **Testing the Effectiveness of Decontamination**

0. Protective clothing or equipment reuse depends on demonstrating that adequate decontamination has taken place. Decontamination methods vary in their effectiveness and unfortunately there are no completely accurate methods for nondestructively evaluating clothing or equipment contamination levels.

1. Methods which may assist in a determination include:

   - Visual examination of protective clothing for signs of discoloration, corrosive effects, or any degradation of external materials. However, many contaminants do not leave any visible evidence.
   - Wipe sampling of external surfaces for subsequent analysis; this may or may not be effective for determining levels of surface contamination and depends heavily on the material-chemical combination. These methods will not detect permeated contamination.
   - Evaluation of the cleaning solution. This method cannot quantify clean method effectiveness since the original contamination levels are unknown. The method can only show if chemical has been removed by the cleaning solution. If a number of garments have been contaminated, it may be advisable to sacrifice one garment for destructive testing by a qualified laboratory with analysis of contamination levels on and inside the garment.

F. **Decontamination Plan**

0. A decontamination plan should be developed and set up before any personnel or equipment are allowed to enter areas where the potential for exposure to hazardous substances exists. The decontamination plan should:

   - Determine the number and layout of decontamination stations;
   - Determine the decontamination equipment needed;
   - Determine appropriate decontamination methods;
   - Establish procedures to prevent contamination of clean areas;

- Establish methods and procedures to minimize wearer contact with contaminants during removal of personal protective clothing; and
- Establish methods for disposing of clothing and equipment that are not completely decontaminated.

1. The plan should be revised whenever the type of personal protective clothing or equipment changes, the use conditions change, or the chemical hazards are reassessed based on new information.

2. The decontamination process should consist of a series of procedures performed in a specific sequence. For chemical protective ensembles, outer, more heavily contaminated items (e.g. outer boots and gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (e.g. jackets and pants). Each procedure should be performed at a separate station in order to prevent cross contamination. The sequence of stations is called the decontamination line.

3. Stations should be separated physically to prevent cross contamination and should be arranged in order of decreasing contamination, preferably in a straight line. Separate flow patterns and stations should be provided to isolate workers from different contamination zones containing incompatible wastes. Entry and exit points to exposed areas should be conspicuously marked. Dressing stations for entry to the decontamination area should be separate from redressing areas for exit from the decontamination area. Personnel who wish to enter clean areas of the decontamination facility, such as locker rooms, should be completely decontaminated.

4. All equipment used for decontamination must be decontaminated and/or disposed of properly. Buckets, brushes, clothing, tools, and other contaminated equipment should be collected, placed in containers, and labeled. Also, all spent solutions and wash water should be collected and disposed of properly. Clothing that is not completely decontaminated should be placed in plastic bags, pending further decontamination and/or disposal.

5. Decontamination of workers who initially come in contact with personnel and equipment leaving exposure or contamination areas will require more protection from contaminants than decontamination workers who are assigned to the last station in the decontamination line. In some cases, decontamination personnel should wear the same levels of protective clothing as workers in the exposure or contaminated areas. In other cases, decontamination personnel may be sufficiently protected by wearing one level lower protection (e.g. wearing Level B protection while decontaminating workers who are wearing Level A).

G. **Decontamination for Protective Clothing Reuse.** Due to the difficulty in assessing contamination levels in chemical protective clothing before and after exposure, the responsible supervisor or safety professional must determine if the respective clothing can be reused. This decision involves considerable risk in determining clothing to be contaminant-free. Reuse can be considered if, in the estimate of the supervisor:

- No "significant" exposures have occurred.
- Decontamination methods have been successful in reducing contamination levels to safe or acceptable concentrations.

Contamination by known or suspected carcinogens should warrant automatic disposal. Use of disposable suits is highly recommended when extensive contamination is expected.

X.

A. **Emergency Decontamination**

0. In addition to routine decontamination procedures, emergency decontamination procedures must be established. In an emergency, the primary concern is to prevent the loss of life or severe injury to personnel. If immediate medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. If decontamination can be performed without interfering with essential life-saving techniques or first aid, or if a worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury or loss of life, decontamination should be continued.

1. If an emergency due to a heat-related illness develops, protective clothing should be removed from the victim as soon as possible to reduce the heat stress. During an emergency, provisions must also be made for protecting medical personnel and disposing of contaminated clothing and equipment.

XI. INSPECTION, STORAGE, AND MAINTENANCE

The end user in donning protective clothing and equipment must take all necessary steps to ensure that the protective ensemble will perform as expected. During emergencies is not the right time to discover discrepancies in the protective clothing. Teach end user care for his clothing and other protective equipment in the same manner as parachutists care for parachutes. Following a standard program for inspection, proper storage, and maintenance along with realizing protective clothing/equipment limitations is the best way to avoid chemical exposure during emergency response.

A. **Inspection**

0. An effective chemical protective clothing inspection program should feature five different inspections:
    - Inspection and operational testing of equipment received as new from the factory or distributor.
    - Inspection of equipment as it is selected for a particular chemical operation.
    - Inspection of equipment after use or training and prior to maintenance.
    - Periodic inspection of stored equipment.
    - Periodic inspection when a question arises concerning the appropriateness of selected equipment, or when problems with similar equipment are discovered.
1. Each inspection will cover different areas with varying degrees of depth. Those personnel responsible for clothing inspection should follow manufacturer directions; many vendors provide detailed inspection procedures. The generic inspection

checklist provided in Table VIII:1-7 may serve as an initial guide for developing more extensive procedures.

2. Records must be kept of all inspection procedures. Individual identification numbers should be assigned to all reusable pieces of equipment (many clothing and equipment items may already have serial numbers), and records should be maintained by that number. At a minimum, each inspection should record:

   - Clothing/equipment item ID number;
   - Date of the inspection;
   - Person making the inspection;
   - Results of the inspection; and
   - Any unusual conditions noted.

   Periodic review of these records can provide an indication of protective clothing which requires excessive maintenance and can also serve to identify clothing that is susceptible to failure.

TABLE VIII:1-7. SAMPLE PPE INSPECTION CHECKLISTS

Clothing	
Before use:	Determine that the clothing material is correct for the specified task at hand.
Visually inspect for:	▪ Imperfect seams; ▪ Nonuniform coatings; ▪ Tears; and ▪ Malfunctioning closures.
Hold up to light and check for pinholes	
Flex product:	▪ Observe for cracks. ▪ Observe for other signs or shelf deterioration.
If the product has been used previously, inspect inside and out for signs of chemical attack:	▪ Discoloration ▪ Swelling ▪ Stiffness
During the work task, periodically inspect for:	▪ Evidence of chemical attack such as discoloration, swelling, stiffening and softening. ▪ Keep in mind, however, that chemical permeation can occur without any visible effects. ▪ Closure failure ▪ Tears ▪ Punctures

	▪ Seam discontinuities
Gloves	
Before use:	Pressurize glove to check for pinholes. Either blow into glove, then roll gauntlet towards fingers or inflate glove and hold under water. In either case, no air should escape.
Fully Encapsulating Suits	
Before use:	▪ Check the operation of pressure relief valves ▪ Inspect the fitting of wrists, ankles, and neck ▪ Check faceshield, if so equipped, for: - cracks - crazing - fogginess

B. **Storage**

0. Clothing must be stored properly to prevent damage or malfunction from exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures and impact. Procedures are needed for both initial receipt of equipment and after use or exposure of that equipment. Many manufacturers specify recommended procedures for storing their products. These should be followed to avoid equipment failure resulting from improper storage.

1. Some guidelines for general storage of chemical protective clothing include:

   - Potentially contaminated clothing should be stored in an area separate from street clothing or unused protective clothing.
   - Potentially contaminated clothing should be stored in a well-ventilated area, with good air flow around each item, if possible.
   - Different types and materials of clothing and gloves should be stored separately to prevent issuing the wrong material by mistake (e.g. many glove materials are black and cannot be identified by appearance alone).
   - Protective clothing should be folded or hung in accordance with manufacturer instructions.

C. **Maintenance**

0. Manufacturers frequently restrict the sale of certain protective suit parts to individuals or groups who are specially trained, equipped, or authorized by the manufacturer to purchase them. Explicit procedures should be adopted to ensure that the appropriate level of maintenance is performed only by those individuals who have this specialized training and equipment. In no case should you attempt to repair equipment without

checking with the person in your facility who is responsible for chemical protective clothing maintenance.

1. The following classification scheme is recommended to divide the types of permissible or nonpermissible repairs:
   - **Level 1:** User or wearer maintenance, requiring a few common tools or no tools at all.
   - **Level 2**: Maintenance that can be performed by the response team's maintenance shop, if adequately equipped and trained.
   - **Level 3** : Specialized maintenance that can be performed only by the factory or an authorized repair person.
2. Each facility should adopt the above scheme and list which repairs fall into each category for each type of protective clothing and equipment. Many manufacturers will also indicate which repairs, if performed in the field, void the warranty of their products. All repairs made must be recorded on the records for the specific clothing along with appropriate inspection results.

XII. TRAINING

A. **Benefits**. Training in the use of protective clothing:

- Allows the user to become familiar with the equipment in a nonhazardous, nonemergency condition.
- Instills confidence of the user in his/her equipment.
- Makes the user aware of the limitations and capabilities of the equipment.
- Increases worker efficiency in performing various tasks.
- Reduces the likelihood of accidents during chemical operations.

B. **Content**. Training should be completed prior to actual clothing use in a non-hazardous environment and should be repeated at the frequency required by OSHA SARA III legislation. As a minimum the training should point out the user's responsibilities and explain the following, using both classroom and field training when necessary, as follows:

- The proper use and maintenance of selected protective clothing, including capabilities and limitations.
- The nature of the hazards and the consequences of not using the protective clothing.
- The human factors influencing protective clothing performance.
- Instructions in inspecting, donning, checking, fitting, and using protective clothing.
- Use of protective clothing in normal air for a long familiarity period.
- The user's responsibility (if any) for decontamination, cleaning, maintenance, and repair of protective clothing.
- Emergency procedures and self-rescue in the event of protective clothing/ equipment failure.
- The buddy system.

The discomfort and inconvenience of wearing chemical protective clothing and equipment can create a resistance to its conscientious use. One essential aspect of training is to make the user aware of the need for protective clothing and to instill motivation for the proper use and maintenance of that protective clothing.

XIII. **RISKS**

A. **Heat Stress**. Wearing full body chemical protective clothing puts the wearer at considerable risk of developing heat stress. This can result in health effects ranging from transient heat fatigue to serious illness or death. Heat stress is caused by a number of interacting factors, including:

- Environmental conditions;
- Type of protective ensemble worn;
- The work activity required; and
- The individual characteristics of the responder.

When selecting chemical protective clothing and equipment, each item's benefit should be carefully evaluated for its potential for increasing the risk of heat stress. For example, if a lighter, less insulating suit can be worn without a sacrifice in protection, then it should be. Because the incidence of heat stress depends on a variety of factors, all workers wearing full body chemical protective ensembles should be monitored.

Review Paragraph III: Chapter 4, Heat Stress, in the OSHA Technical Manual. The following physiological factors should be monitored.

XIV.

A. **Heart Rate.** Count the radial pulse during a 30-second period as early as possible in any rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle should be shortened by one-third.

B. **Oral Temperature**

0. *Do not permit an end user to wear protective clothing and engage in work when his or her oral temperature exceeds 100.6°F (38.1°C).*

1. Use a clinical thermometer (three minutes under the tongue) or similar device to measure oral temperature at the end of the work period (before drinking), as follows:

    - If the oral temperature exceeds 99.6°F (37.6°C), shorten the next work period by at least one-third.
    - If the oral temperature exceeds 99.6°F (37.6°C) at the beginning of a response period, shorten the mission time by one-third.

C. **Body Water Loss.** Measure the end user's weight on a scale accurate to plus or minus 0.25 pounds prior to any response activity. Compare this weight with his or her normal body weight to determine if enough fluids have been consumed to prevent dehydration. Weights should be taken while the end user wears similar clothing, or ideally, in the nude. The body water loss should not exceed 1.5% of the total body weight loss from a response.

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