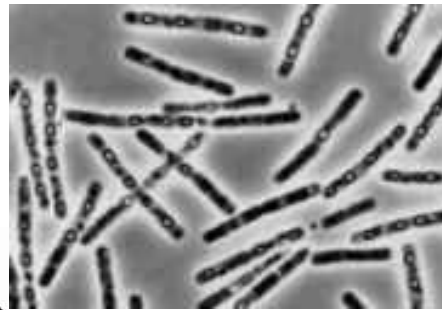


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August 2003

Personal Protective Equipment Guide for Military Medical Treatment Facility Personnel Handling Casualties from Weapons of Mass Destruction and Terrorism Events



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PREFACE

Purpose and Scope

This Technical Guide (TG) provides personal protective equipment (PPE) guidance to Army Medical Department (AMEDD) Military Medical Treatment Facility (MTF) Personnel Handling Casualties from Weapons of Mass Destruction and Terrorism at their fixed facilities. It provides guidance relating to the selection of PPE and program requirements for PPE use.

Intended Audience

This TG is intended for the Hospital Commander and staff, e.g., Doctors, Nurses, Emergency Medical Technicians (EMTs), Ambulance Crew, Safety Managers, Industrial Hygienists, and Administrative Personnel responsible for plans, training, mobilization, and security. This guidance is NOT intended to apply to AMEDD soldier field deployments during training, peacetime, or wartime - consult appropriate Army Field Manuals and other references for these situations, such as Medical Management of Chemical Casualties Handbook (USAMRICD), Treatment of Biological Warfare Agent Casualties (Army FM 8-284), Medical Management of Biological Casualties Handbook (USAMRIID), Medical Management of Radiological Casualties (AFRRI), and The Medical NBC Battlebook (USACHPPM TG 244).

User Comments

The proponent of this publication is the U.S. Army Center for Health Promotion and Preventive Medicine. Please forward all recommendations to Commander, USACHPPM, ATTN: MCHB-TS-OFS, APG-EA, MD, 21010-5422.

Cover Page

An explanation of the cover page photographs, starting from the bottom left and as presented clockwise: attack on the Pentagon (September 11, 2001); simulated hospital; *Bacillus anthracis* (causes the disease, Anthrax); and, a simulated decontamination of a victim at an incident site (personnel in Level A PPE have delivered a non-ambulatory victim from the exclusion zone to two people performing decontamination in Level B PPE in the decontamination reduction zone. Level C PPE would look similar to Level B PPE except an air-purifying respirator is worn instead of an atmosphere-supplying respirator, such as the Self-Contained Breathing Apparatus worn by those in this picture.)

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SECTION I: BACKGROUND INFORMATION

CHAPTER 1: BIOLOGICAL WARFARE AGENT TERRORISM

1.1. General.

1.1.1. Introduction.

- A. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.
- B. A list of references cited in this Chapter can be found in Appendix B. Also, in the last paragraph of this Chapter, a couple of references are indicated that the reader might look for further details.
- C. Selection of PPE is discussed in Section II. Chapters 5 and 6 of Section II discuss PPE selection issues relevant to biological warfare agent (BWA) terrorism.
- D. Program requirements for PPE use are discussed in Section III.
- E. The following provides a brief description of the BWAs likely to be used in a terrorist attack. There are three categories under discussion: bacterial agents, viral agents, and toxins. The microorganisms and toxins described below are all considered etiologic agents and are capable of producing disease in humans.

1.1.2. Bacterial Agents.

A. Disease Producing Mechanisms and Medical Treatment.

- (1) Bacteria generally cause disease in human beings and animals by invading host tissues and/or by producing poisons (toxins) (Ref. 48) or by producing abnormal immune responses.
- (2) The diseases they produce often respond to specific therapy with antibiotics (Ref. 48). Immunization is sometimes possible.

B. Size and Shape.

- (1) Cocci, Bacilli, and Rickettsiae. Bacteria are small, single-celled organisms, most of which can be grown on solid or liquid culture media (Ref. 65a). They vary in shape and size from spherical cells (cocci) with a diameter of 0.5-1.0 micrometer (μm), to long rod-shaped organisms (bacilli) that may be from 1-5 μm in size (Ref. 48). Chains of bacilli may exceed 50 μm in length (Ref. 48). *Bacillus anthracis* (causes the disease, Anthrax) is a nonmotile bacillus

of the following dimensions: 1-1.5 μm x 3-10 μm (Ref. 51). Rickettsiae are intermediate in size between most bacteria and viruses (Ref. 65a).

(2) Spores. Under special circumstances, some types of bacteria (e.g., *Bacillus anthracis*) can transform into spores that are more resistant to cold, heat, drying, chemicals, and radiation than the vegetative bacterium itself (Ref. 48). These are the very properties that could be advantageous when choosing a biological weapon (Ref. 48). Spores are a dormant form of the bacterium and, like the seeds of plants, they can germinate when conditions are favorable (Ref. 48). Anthrax spores are oval shaped (Ref. 51) and are about 1 μm in physical diameter (Ref. 51, Ref. 96). When inhaled, the spores are small enough to penetrate into the deep lung (pulmonary region). Inhalation anthrax may result if the inhaled dose is greater than the infective dose.

C. Rickettsia. The term rickettsia generally applies to very small, gram-negative coccobacillary organisms of the genera *Rickettsia* and *Coxiella* (Ref. 48). Rickettsiae are unique from classical bacteria in their inability to grow (with rare exceptions) in the absence of a living host cell, but many are susceptible to treatment with antibiotics (Ref. 48). Rickettsiae are obligate intracellular bacteria that possess certain characteristics common to both bacteria and viruses (Ref. 65a). Like bacteria, they have metabolic enzymes and cell membranes, use oxygen, and are susceptible to broad-spectrum antibiotics; but like viruses, they grow only in living cells. Q fever is a disease caused by *Coxiella burnetii*, a rickettsia-like organism of low virulence but remarkable infectivity (Ref. 51). It forms a spore-like organism that is extremely heat-, pressure-, desiccation-, and antiseptic-resistant and can persist in the environment for weeks to months under harsh conditions. *Coxiella burnetii* is classified in the family Rickettsiaceae, but is not included in the genus *Rickettsia* and therefore is not a true rickettsia (Ref. 51).

D. Disease, Etiologic Agent, and Infective Doses (Via Inhalation of Aerosol).

- Inhalation Anthrax (*Bacillus anthracis* spores) [The Defense Intelligence Agency (1986) indicate an estimated human LD₅₀ between 8,000 and 10,000 spores, Ref. 148. Inglesby, T.V. et. al. (2002) indicate that extrapolations from animal data suggest a human LD₅₀ of 2,500 to 55,000 spores, Ref. 96.]
- Brucellosis (*Brucellae* species) (10-100 organisms, Ref. 48)
- Glanders (*Burkholderia mallei*) (100 – 1,000 organisms, Ref. 142)
- Pneumonic Plague (*Yersinia pestis*)(100-500 organisms, Ref. 48)
- Tularemia (*Francisella tularensis*) (10-50 organisms, Ref., 48)
- Q Fever (*Coxiella burnetii*) (1-10 organisms, Ref. 48)

E. Incubation Periods (Ref. 48).

- Inhalation Anthrax (usually 1-6 days after inhalation, but sometimes longer)
- Brucellosis (5-60 days after inhalation, usually 1-2 months)
- Glanders (10-14 days after inhalation)
- Pneumonic Plague (1-6 days after inhalation, usually 2-4 days)
- Tularemia (2-10 days after inhalation, average of 3-5 days)
- Q Fever (10-40 days)

F. Signs, Symptoms, and Case-Fatality Rates.

- **Inhalation Anthrax:** Fever, malaise, fatigue, cough and mild chest discomfort progresses to severe respiratory distress with labored or difficult breathing, profuse sweating, stridor, cyanosis, and shock (Ref. 48). The case-fatality rate for untreated inhalation anthrax is over 90% (Ref. 146). Almost all inhalational anthrax cases in which treatment was begun after patients were significantly symptomatic have been fatal, regardless of treatment (Ref. 48). Death typically occurs within 24-36 hours after onset of severe symptoms (Ref. 48).
- **Brucellosis (Ref. 48):** Illness, when manifest, typically presents with fever, headache, muscle pain or tenderness, joint pains, back pain, sweats, chills, and generalized malaise. Other manifestations include depression, mental status changes, and osteoarticular findings (i.e. inflammation of the sacroiliac joint, inflammation of vertebral bone). Case-fatalities are uncommon (< 5%) when left untreated.
- **Glanders (Ref. 48):** Onset of symptoms may be abrupt or gradual. Inhalational exposure produces fever (common in excess of 102 °F.), rigors, sweats, muscle pain or tenderness, headache, pleuritic chest pain, swelling and morbid change in lymph nodes in neck, enlargement of liver and spleen, and generalized papular/pustular eruptions. Acute pulmonary disease can progress and result in bacteremia and acute septicemic disease. Glanders is almost always fatal without treatment.
- **Pneumonic Plague (Ref. 48):** high fever, chills, headache, malaise, followed by cough (often with hemoptysis), progressing rapidly to labored or difficult breathing, stridor, cyanosis, and death. Gastrointestinal symptoms are often present. Death results from respiratory failure, circulatory collapse, and a bleeding diathesis. Bubonic plague, featuring high fever, malaise, and painful lymph nodes (buboes) may progress spontaneously to the septicemic form [septic shock, thrombosis, disseminated intravascular coagulation (DIC)] or to the pneumonic form. Pneumonic plague has a case-fatality rate of nearly 100% unless it is treated within 18 hours.
- **Tularemia:** ulceroglandular tularemia presents with a local ulcer and regional lymph node disease, fever, chills, headache and malaise (Ref. 48). Typhoidal tularemia presents with fever, headache, malaise, substernal discomfort, absolute exhaustion, weight loss and a non-productive cough (Ref. 48). Pneumonia is one of the main manifestations after a BWA attack. If untreated, tularemia has a case-fatality rate of 40% for Type A and 5% for Type B.
- **Q Fever:** fever, cough, and pleuritic chest pain may occur as early as ten days after exposure (Ref. 48). Patients are not generally critically ill, and the illness lasts from 2 days to 2 weeks (Ref. 48). Later complications such as endocarditis are a concern. Q fever has a very low case-fatality rate (Ref. 48) – death is rare.

1.1.3. Viral Agents.

A. Disease Producing Mechanisms and Medical Treatment.

(1) Viruses are the smallest organisms identified by use of electron microscope (Ref. 79). Viruses comprise a central core of either DNA or RNA, surrounded by a protein coating, or capsid; some viruses create an additional covering (called an envelope) from the cytoplasm of the cell (Ref. 79). Because viruses lack a system for their own metabolism, they require living hosts (cells of an infected organism) for replication (Ref. 65a).

(2) As BWAs, they are attractive because many do not respond to antibiotics (Ref. 65a), though some antiviral medications are being developed or applied in some cases. Immunization is sometimes possible.

B. Size and Shape. Viruses are much smaller than bacteria and vary in size from about 0.02 μm to 0.2 μm (Ref. 48).

- Variola (causes smallpox) is one of the larger viruses: one source has its dimensions as about 0.4 x 0.2 μm , whereas another has general Poxviridae family viral sizes as about 0.25 x 0.15 μm , and another has pox viruses at 0.22-0.35 to 0.11-0.26 μm , <http://www.stanford.edu/group/virus/pox/pox.html>, <http://www.ucd.ie/~virusref/vrlem.html>, <http://www.geocities.com/kimmyscreams/Variola.html>.

- Marburg virions are 0.08 μm in diameter and 0.79 μm in length (Ref. 40). Ebola virions are 0.08 μm in diameter and 0.97 μm in length (Ref. 40). Longer, bizarre virion related structures of Ebola and Marburg may be branched or coiled and reach 10 μm in length (Ref. 40).

- Hantaviruses are 0.095 to 0.110 μm in diameter (Ref. 40).

- An alphavirus (e.g., VEE, WEE, and EEE viruses) virion is a spherical particle of about 0.06 to 0.065 μm in diameter (Ref. 51).

- Yellow fever virus particles range from 0.017 to 0.028 μm in diameter (Ref. 146).

C. Disease, Etiologic Agent, and Infective Doses (Via Inhalation of Aerosol).

- Smallpox (Orthopoxvirus genus, variola species) (10-100 organisms) (Ref. 48)
- Venezuelan Equine Encephalitis (*Alphavirus* genus, VEE species) (10-100 organisms) (Ref. 48)
- Viral Hemorrhagic Fevers (VHFs). All of the VHF agents (except for dengue virus) have been found to be infectious by aerosol (Ref. 48). The etiologic agent and infective dose varies with the disease (virus, family/genus) – for example:

Lassa fever (Lassa virus, *Arenaviridae/Arenavirus*, Ref. 51) (10-100 pfu, Ref. 142)
 Argentine HF (Junin virus, *Arenaviridae/Arenavirus*, Ref. 51) (10-100 pfu, Ref. 142)
 Bolivian HF (Machupo virus, *Arenaviridae/Arenavirus*, Ref. 51) (10-100 pfu, Ref. 142)
 Brazilian HF (Sabia virus, *Arenaviridae/Arenavirus*, Ref. 51)

Venezuelan HF (Guanarito, *Arenaviridae/Arenavirus*, Ref. 51)
 Crimean-Congo HF (Crimean-Congo virus, *Bunyaviridae/Nairovirus*)
 Marburg HF (Marburg virus, *Filoviridae/Filovirus*, Ref. 51) (a few virions, Ref. 100; 1-10 pfu, Ref. 142)
 Ebola HF (Ebola virus, *Filoviridae/Filovirus*, Ref. 51) (1-10 pfu, Ref. 142)
 Rift Valley fever (Rift valley fever virus, *Bunyaviridae/Phlebovirus*, Ref. 51)
 HF with renal syndrome (HFRS) (Hantaan and related viruses, *Bunyaviridae/Hantavirus*, Ref. 51)
 Yellow fever (yellow fever virus, *Flaviviridae/Flavivirus*, Mosquito-borne, Ref. 51)
 Dengue HF (dengue virus, *Flaviviridae/Flavivirus*, Mosquito-borne, Ref. 51)
 Kyasanur Forest disease (Kyasanur forest virus, *Flaviviridae/Flavivirus*, Tick-borne, Ref. 51)
 Omsk HF (Omsk HF virus, *Flaviviridae/Flavivirus*, Tick-borne, Ref. 51)

D. Incubation Periods.

- Smallpox (7-19 days, average 12 days) (Ref. 48)
- Venezuelan Equine Encephalitis (1-6 days) (Ref. 48)
- Viral Hemorrhagic Fevers. The incubation period varies with the disease – for example (Ref. 51):

Lassa fever (5-16 days, Ref. 51)
 Argentine HF (7-14 days, Ref. 51)
 Bolivian HF (9-15 days, Ref. 51)
 Brazilian HF (7-14, Ref. 51)
 Venezuelan HF (7-14, Ref. 51)
 Crimean-Congo HF (3-12 days)
 Marburg and Ebola HF (3-16 days)
 Rift Valley fever (2-5 days)
 HFRS (9-25 days)
 Yellow fever (3-6 days)
 Dengue HF (unknown for dengue HF, but 3-5 days for uncomplicated dengue)
 Kyasanur Forest disease (3-8 days)
 Omsk HF (3-8 days)

E. Signs, Symptoms, and Case-Fatality Rates.

- Smallpox: clinical manifestations begin acutely with malaise, fever, rigors, vomiting, headache, and backache (Ref. 48). Two to three days' later lesions appear which quickly progress from macules to papules, and eventually to pustular vesicles (Ref. 48). They are more abundant on the extremities (including palms and soles, Ref. 45) and face, and develop synchronously (Ref. 48). The rash scabs over in 1-2 weeks (Ref. 45). For the classic variety, case-fatality rates are about 30% in the unvaccinated (Ref. 51). A rarer clinical form is flat-type smallpox, with a 95% case-fatality rate in the unvaccinated (Ref. 51).

- Venezuelan Equine Encephalitis (Ref. 48): acute systemic febrile (feverish) illness with inflammation of the brain developing in a small percentage (4% children; < 1% adults) (Ref. 48). Generalized malaise, spiking fevers, rigors, severe headache, unusual intolerance of light, and muscle pain or tenderness for 24-72 hours (Ref. 48). Nausea, vomiting, cough, sore throat, and diarrhea may follow. Full recovery from malaise and fatigue takes 1-2 weeks (Ref. 48). The incidence of central nervous system

disease and associated morbidity and mortality would be much higher after a BWA attack. Venezuelan equine encephalitis has a case-fatality rate of < 1% (Ref. 48).

- **Viral Hemorrhagic Fevers:** febrile (feverish) illnesses which can feature flushing of the face and chest, skin spots (small, purplish, hemorrhagic spots), bleeding, edema, low blood pressure, and shock (Ref. 48). Malaise, muscle pain or tenderness, headache, vomiting, and diarrhea may occur in any of the hemorrhagic fevers (Ref. 48). Case-fatality rates vary markedly, e.g., 0.5% for Omsk hemorrhagic fever (Ref. 100), 5-15% for HFRS (Ref. 40), 5-40% for yellow fever (5% among indigenous populations in endemic regions, but may reach 20-40% in individual outbreaks, Ref. 40), 15% for Lassa Fever (15% among hospitalized cases, though overall, only 1% of infected persons die, Ref. 40), 15-35% for South American HFs (Argentinian, Bolivian, Venezuelan, Brazilian HFs, Ref. 40), 2-50% for Crimean-Congo HF (Ref. 40), 25% for Marburg HF (Ref. 146), 53% for Ebola-Sudan HF (Ref. 51), and 75-95% for Ebola-Zaire HF (Ref. 51).

1.1.4. Toxins.

A. Origin and Disease Producing Mechanism. Biological toxins are poisons produced by living organisms (animals, plants, microbes) (Ref. 48). It is the poison and not the organism that produces harmful effects in humans (Ref. 65a). A toxin typically develops naturally in a host organism (for example, saxitoxin is produced by marine algae); however, genetically altered and/or synthetically manufactured toxins have been produced in a laboratory environment.

B. Physical and Toxicology Comparisons to Chemical Warfare Agent. Biological toxins are most similar to chemical agents in their dissemination and effectiveness (Ref. 65a). Features that distinguish toxins from chemical agents, such as VX, cyanide, or mustard, include the fact they occur naturally (not man-made), they are non-volatile (no vapor hazard), are usually not dermally active (mycotoxins are the exception), and generally are much more toxic per weight than chemical warfare agents (Ref. 48). The following is an LD₅₀ (in mice) or ED₅₀ Rhesus for SEB) and Molecular Weight comparison between some toxins and chemical warfare agent, in order from highest to lowest toxicity (Ref. 48):

- *Botulinum toxin* (0.001 µg/kg), MW: 150,000
- *Ricin toxin* (3-5 µg/kg), MW: 64,000
- VX chemical warfare agent (15 µg/kg), MW: 267
- *Staphylococcal Enterotoxin B (SEB) toxin* (Rhesus/Aerosol) (27 µg/kg) (ED₅₀-pg), MW: 28,494
- Soman/GD chemical warfare agent (64 µg/kg), MW: 182
- Sarin/GB chemical warfare agent (100 µg/kg), MW: 140
- T-2 toxin (1,210 µg/kg), MW: 466

C. Toxin Doses (Aerosol) Necessary to Produce a Harmful Effect.

- Botulinum (0.003 µg/kg is estimated human LD₅₀ for type A, Ref. 51; also, for Type A, it is estimated that about 50% of persons will become ill after inhaling 0.00024 µg)

- Ricin (3-5 µg/kg is LD₅₀ in mice, Ref. 48)
- SEB (0.0004 µg/kg is incapacitation dose for 50% of humans; LD₅₀ for humans is estimated to be about 0.02 µg/kg)
- T-2 toxin (1250 µg/kg, LD₅₀, mice)

D. Time Delay to Onset of Signs and Symptoms (Ref. 48). The four toxins below are considered to be the most likely to be used against U.S. military and civilian targets (Ref. 48). A vaccine and antitoxin is available for botulism, but not for the other toxins indicated (Ref. 48). The time to onset of signs and symptoms for these toxins to cause disease is as follows (Ref. 48):

- Botulism (12-36 hours after inhalation; several days if inhalation dose is low)
- SEB (3-12 hours after inhalation)
- Ricin (4-8 hours after inhalation; pulmonary edema could result within 18-24 hours)
- T-2 Mycotoxin (minutes to hours)

E. Signs, Symptoms, and Case-Fatality Rates.

- Botulism: usually begins with cranial nerve paralysis, including ptosis (drooping eyelids), blurred vision, double vision, dry mouth and throat, inability to swallow or difficulty swallowing, and difficulty speaking (hoarseness) (Ref. 48). This is followed by symmetrical descending flaccid paralysis, with generalized weakness and progression to respiratory failure (Ref. 48). Symptoms begin as early as 12-36 hours after inhalation, but may take several days after exposure to low doses of toxin (Ref. 48). Botulism case-fatality rate is 90% without respiratory support.

- SEB (Ref. 48): sudden onset of fever, chills, headache, muscle pain or tenderness, and nonproductive cough, after inhalation. Some patients may develop shortness of breath and chest pain behind the sternum. Patients tend to plateau rapidly to a fairly stable clinical state. Fever may last 2 to 5 days, and cough may persist for up to 4 weeks. Patients may also present with nausea, vomiting, and diarrhea if they swallow the toxin. Presumably, higher exposure can lead to septic shock and death. SEB has a case-fatality rate of < 1%.

- Ricin (Ref. 48): acute onset of fever, chest tightness, cough, labored or difficult breathing, nausea, and joint pains. Airway necrosis and pulmonary capillary leak resulting in pulmonary edema would likely occur within 18-24 hours, followed by severe respiratory distress and death from hypoxemia in 36-72 hours. There is a high lethality/death rate associated with ricin.

- T-2 Mycotoxin (Ref. 48): Exposure causes skin pain, severe itching, redness, vesicles, necrosis and sloughing of the epidermis. Effects on the airway include nose and throat pain, nasal discharge, itching and sneezing, cough, labored or difficult breathing, wheezing, chest pain and hemoptysis. Toxin also produces effects after ingestion or eye contact. Severe intoxication results in absolute exhaustion, weakness, ataxia, collapse, shock, and death. There is a moderate lethality/death rate associated with T-2 Mycotoxin.

1.2. Transmission of Bioaerosols and Diseases. It is important to distinguish between how diseases may be contracted after a BWA attack.

1.2.1. Bioaerosol Hazards (after initial aerosol release/generation or reaerosolization) and Contact Hazards After a Bioterrorism Attack.

A. A terrorist may disseminate any of the BWAs (indicated above) into the air, where they may be inhaled and cause disease if the inhaled dose exceeds the infective (or effective dose for toxins) dose (which can vary from person to person). The inhalation route of entry into the body is by far the most important to consider when planning defenses against BWA attacks (Ref. 51). A well designed BWA aerosol is expected to be in the size range of 1-5 μm in diameter, which allows it to be carried in the air for long distances by prevailing winds and also be inhaled deeply into the lungs (Ref. 51, Ref. 146). BWAs may also enter through broken skin or through the mucous membranes of the eyes, nose, or mouth, or through the gastrointestinal tract if swallowed.

B. The airborne concentration at the incident site would depend upon the amount of agent dispersed into the air, whether or not the agent is still being generated, the air exchange rate (or wind, if outside), how well the air is mixed throughout the room (if indoors), the aerodynamic size of the particles (depends on size, shape, and density), the physical size of the particles, the amount of time elapsed since the aerosol had stopped being generated (i.e., concentrations will diminish with time depending upon the particle properties and particle aerodynamic and physical sizes).

C. The bioaerosols may settle out and contaminate persons, their clothing, or surfaces. Aerosol particles may adhere to surfaces they contact or may form larger agglomerates when they contact each other (Ref. 92). Some bioaerosols may potentially be redispersed into the air (i.e., reaerosolized).

(1) It may be difficult to reliably predict reaerosolization hazards from surface contamination (whether it be on a person or their clothing, inanimate surfaces, soil, or vegetation) due to the high variability in surface properties, variability in properties of the BWA and materials it may be bound to, environmental/human factors affecting resuspension, and the persistence of the BWA in the environmental surroundings. These variables include:

- Properties of the biowarfare agent or materials it may have been treated with, such as adhesive properties, cohesive properties, particle size distribution, particle density, and perhaps even chemical reactivity with normal air gases (oxygen, water, carbon dioxide).
- Properties of the surface, such as macrostructure, microstructure, and adhesive properties with respect to the biowarfare agent or materials it may be treated with or other substances such as dirt or dust that it may adhere to. Also, when the BWA settles onto a surface it may adhere to surrounding substances, such as dust or dirt, which would have properties of its own.
- Environmental/human factors on surfaces at the incident site such as foot traffic, powered and non-powered wheel traffic, vibration, air current velocities, and air exchange rate

(Ref. 128). Other human factors include how roughly victims or their clothing are physically contacted/handled/removed by healthcare or decontamination personnel.

- Environmental persistence of the BWA in the surrounding environmental conditions. Factors that may affect how much BWA remains a potential hazard in the environment may include how long it has been since it has been released and factors such as exposure to ultraviolet light/sunlight; temperature; relative humidity; wet or dry conditions; and whether it is in soil, dust, or exposed to open air. *Bacillus anthracis* spores (causes Anthrax) and *Coxiella burnetii* (causes Q fever) are particularly persistent in the environment. References 134 and 146 contain information on BWA “decay” rates and persistence under various environmental conditions.

(2) The adhesive forces on micrometer-size particles exceed other common forces by orders of magnitude (Ref. 92). As the particle size decreases, it becomes more difficult to remove particles from surfaces (Ref. 92). For instance, everyone has probably experienced the relative difficulty of reaerosolizing or removing from surfaces at least one of the following settled submicrometer (physical diameters $< 1\ \mu\text{m}$) particles: tobacco smoke, oil smoke, rosin smoke, and carbon black (Ref. 129). Compare this to the relative ease of reaerosolizing or removing from surfaces one of the following settled supermicrometer (physical diameters $> 1\ \mu\text{m}$) particles: insecticide dusts (0.5-10 μm), ground talc (0.5-50 μm), milled flour (1-80 μm), coal dust (1-100 μm), fly ash (1-200 μm), cement dust (3-100 μm), plant spores (10-30 μm), pollen (10-100 μm), general road or house dust (3-300 μm , normally, but up to 1 cm), ground limestone fertilizer (10 μm – 1 mm), fine sand (20-200 μm), coarse sand (200 μm – 2 mm), and beach sand (90 μm – 2 mm) (Ref. 129).

(3) According to Hinds (1999), while individual particles less than 10 μm are not likely to be removed from surfaces by common forces, a thick layer of such particles may be easily dislodged in large (100 μm to 10 mm) chunks when blown or shaken from the surface (Ref. 92). It should not be construed from the previous sentence that particles less than 10 μm can not be reaerosolized by common forces, since we now know this is not necessarily the case if the biological agent is weaponized. For example, we now know that settled weaponized Anthrax spores (about 1 μm in physical diameter) can be reaerosolized, as individual spores, as spore agglomerates, or when adhered to other particles (e.g., dust), particle sizes that, when inhaled, can penetrate and deposit into the thoracic and respirable regions of the respiratory tract (Ref. 157). Anthrax spores may be weaponized by reducing the electrostatic charge in a fashion that makes them less able to stick together and therefore have less potential to agglomerate and make larger particles.

(4) There is one statement that can be said with relative certainty with regard to settled particulates, and that is, if reaerosolized, the aerosolized particle distribution will tend to have relatively larger-sized particles and fewer smaller-sized particles than in the originally dispersed aerosol.

D. Immediately following an overt attack, BWA on surfaces (whether it be on a person or their clothing or inanimate surfaces) may pose a threat if contacted by entering through broken

skin or if a contaminated hand/arm or other contaminated item subsequently contacts mucous membranes of eyes, nose, or mouth.

E. PPE guidance is presented in Chapters 5 and 6 to protect response personnel at the incident site and MTF personnel at their fixed facilities when they triage or decontaminate victims of an overt bioterrorist attack.

1.2.2. Diseases Transmitted (and Not Transmitted) from Person to Person. Once the bioaerosol is inhaled by a person or if the agent enters by other means (e.g., broken skin, mucous membranes of the mouth or nose), a person may contract the disease if the dose exceeds the infective dose (varies from person to person) and after the incubation period (see above) for the BWA that causes the disease. If the person develops the disease, it may or may not be transmissible to another person. PPE guidance is provided in Chapter 6 for those coming in contact with patients having contracted a disease caused by a bioterrorist agent.

A. Diseases **Not** Transmitted From Person to Person.

- Inhalation Anthrax (Ref. 48)
- Brucellosis (Ref. 48)
- Tularemia (Ref. 48)
- Botulism (Ref. 48)
- SEB (Ref. 48)
- Ricin (Ref. 48)
- T-2 Mycotoxin (Ref. 48)
- Rift Valley Fever (Ref. 100)
- Yellow Fever (Ref. 100)
- Omsk HF (Ref. 100)
- Kyasanur Forest Disease (Ref. 100)
- Dengue HF (Ref. 48, Ref. 51)

B. Diseases **Rarely** Transmitted from Person to Person.

- Cholera (Ref. 48)
- Q Fever (Ref. 48)
- HF with renal syndrome (HFRS) (Hantaan and related viruses) (Ref. 40)

C. Diseases Transmitted at **Low Rate** from Person to Person (Ref. 48).

- Glanders
- Venezuelan Equine Encephalitis

D. Diseases Transmitted at a **Moderate Rate** from Person to Person (Ref. 48).

- Certain Viral Hemorrhagic Fevers [e.g, Lassa fever, Crimean-Congo HF, Marburg HF, and Ebola HF (Ref. 48). Since 1967, there have been 18 reports of human outbreaks of VHF secondary to Ebola or Marburg viruses, resulting in approximately 1500 cases to date. Epidemiological investigation

indicates that most cases occurred after direct contact with blood, secretions, or tissues of infected patients or nonhuman primates (Ref. 100). Risk of transmission is low during the incubation period and highest during the late stages of illness when the patient is vomiting, having diarrhea, or hemorrhaging (Ref. 40). Indirect contact via person-to-person airborne transmission of HFVs appears to be a rare event but cannot be conclusively ruled out (Ref. 100).]

E. Diseases Transmitted at a **High Rate** from Person to Person (Ref. 48).

- **Pneumonic Plague** [Pneumonic plague is transmitted via large respiratory droplets, generally larger than 5 µm (Ref. 45). Neither bubonic nor septicemic plague spreads directly from person to person, though a small percentage (about 12% of total cases in the U.S. over the past 50 years) of patients with bubonic or septicemic plague develop secondary pneumonic plague and can then spread the disease by expelled respiratory droplets (Ref. 35)]

- **Smallpox** [Patient-to-patient transmission is likely from airborne droplet nuclei (small particle residue, 5 µm or smaller in size, of evaporated respiratory droplets) and large respiratory droplets (generally larger than 5 µm), and by contact with skin lesions or secretions (Ref 45). Patients are considered more infectious if coughing or if they have a hemorrhagic form of smallpox (Ref 45).]

1.3. Covert and Overt Bioterrorism.

1.3.1. Covert.

A. Bioterrorism may occur as a covert event, in which persons are unknowingly exposed and an outbreak is suspected only upon recognition of unusual disease clusters or symptoms (Ref. 45).

B. Victims will not likely present for medical care until days after an attack – at this point the need for decontamination is minimal or non-existent (Ref. 43, 45, 48). By this time, the victims probably have showered and changed clothes since the time they were exposed and their symptoms appeared.

C. Subsequent investigations may result in suspicion that a particular site may be contaminated. For instance, disease victims may have all been to a common area within a particular period of time and have all come down with the same disease within a time period consistent with the incubation period for the disease.

D. Investigative personnel that go to suspected incident site areas should follow the PPE guidance indicated in Chapters 5 and 6.

1.3.2. Overt.

A. Rarely, a BWA release will be announced, immediately perceived, or discovered immediately after dissemination, and asymptomatic patients may present after acute exposure to a potentially infectious agent (Ref. 71).

B. These patients may have contamination on their bodies and clothing that may pose a skin contact threat or reaerosolize (posing an inhalation threat) when handling or decontaminating these patients. These patients are not likely to present with symptoms of the disease or be contagious because of the incubation periods for BWAs. That is, the initial potential threat would not be in a victim spreading a disease to another person, but rather in carrying the agent on their bodies which may pose a reaerosolization or skin contact threat to others, but only likely in situations where the person is physically contacted or their clothing is handled in such a fashion to make this occur.

C. Response personnel entering the incident site or those encountering or decontaminating these patients (at the incident site or at the MTF) should wear the PPE indicated in Chapters 5 and 6.

1.4. Vaccinations and Medication for MTF Staff and Emergency Responders.

1.4.1. Public health/preventive medicine officials should determine a strategy for prophylaxis (vaccines, medication) for all at-risk MTF or response personnel that are exposed or in danger of exposure to a bioterrorism agent, whether it be for protection against biowarfare agents generated after an attack or for protection of MTF personnel caring for a contagious ill person. When evaluating the potential for risk of exposure, the following factors should be considered:

- Risk of inhaling a dose that may cause disease, which depends on whether a respirator is worn or not and the protection factor of the respirator, the airborne concentration of the etiologic agent, the exposure duration, exposure frequency, and volume of air inhaled
- Risk of accidental puncture with sharps (i.e., needle or other sharp object)
- Potential for the BWA to contact and enter through broken skin
- Potential for contacting potentially infectious materials or body fluid, either intentionally or accidentally, by direct contact or via splashed, spilled, or sprayed fluids
- Potential for potentially contaminated hands/arms or other contaminated materials inadvertently or accidentally coming into contact with the mucous membranes of the eyes, nose, or mouth

1.4.2. Special immunizations (when available) should be considered for at-risk personnel whose duties might potentially expose them to certain etiologic agents. The special immunization program must be in accordance with OASA (I&E) memorandum, subject: Special Immunization Program.

A. Licensed vaccines for which the benefits (levels of antibody considered protective) clearly exceed the risks (e.g., local or systemic reactions) should be required for all clearly identified at-risk personnel (Ref. 39). A statement of declination may be required if the at-risk individual declines a licensed vaccine.

B. Recommendations for giving less efficacious vaccines, those associated with high rates of local or systemic reactions, those that produce increasingly severe reactions with repeated use, and unlicensed vaccines given under investigational new drug (IND) protocols, should be carefully considered (Ref. 39), and the decision to use made according to the benefit and risk. INDs are not available commercially, and can only be given under a specific protocol of informed consent (Ref. 48).

1.4.3. Agencies employing immunoprophylaxis as a means of personal protection will develop a written immunoprophylaxis program and SOPs as described in DA PAM 385-69, Biological Defense RDTE Safety Standards.

1.4.4. For vaccines, therapeutics, and prophylaxis for use against biowarfare agents, consult Appendix D of the USAMRIID reference (with website hyperlink) cited below and the USAMRIID CD-ROM, Medical Management of Biological Warfare Casualties.

1.4.5. A medical surveillance program (see AR 40-5, Ref. 2) will be established for all personnel who may be potentially exposed to etiologic agents. The determination as to who to include in the medical surveillance program will be made by the installation medical authority as defined in AR 40-5. Pre-placement, periodic, and termination medical surveillance examinations will be conducted for each worker to establish a baseline health record and to provide periodic job-related assessments of the worker's health status.

1.5. References for Further Details.

- USAMRIID's Medical Management of Biological Casualties Handbook, Fourth Edition, February 2001. Website hyperlink: <http://www.usamriid.army.mil/education/bluebook.html>

- Textbook of Military Medicine, Part I, Medical Aspects of Chemical and Biological Warfare, Office of the Surgeon General, Department of the Army, 1997. Website hyperlink: <http://www.nbc-med.org/SiteContent/HomePage/WhatsNew/MedAspects/contents.html>

- US Chemical-Biological Defense Guidebook, Jane's Information Group, 1997.

- Franz, D., Defense Against Toxin Weapons, USAMRIID, 1997, <http://www.usamriid.army.mil/education/defensetox.html>

- OSHA Bioterrorism Website: <http://www.osha.gov/SLTC/biologicalagents/bioterrorism.html>

- CDC Biological Agents/Diseases Website: <http://www.bt.cdc.gov/agent/agentlist.asp>

SECTION I: BACKGROUND INFORMATION

CHAPTER 2: CHEMICAL WARFARE AGENT TERRORISM

2.1. General.

2.1.1. Introduction.

A. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

B. A list of references cited in this Chapter can be found in Appendix B. Also, in the last paragraph of this Chapter, a couple of references are indicated that the reader might look for further details.

C. Selection of PPE is discussed in Section II. Chapters 5 and 7 of Section II discuss PPE selection issues relevant to chemical warfare agent terrorism.

D. Program requirements for PPE use are discussed in Section III.

E. Chemical Warfare Agent (CWA) Overview.

(1) CWAs are chemical substances that are intended for use in warfare or terrorist activities to kill, seriously injure, or seriously incapacitate people through their physiological effects (Ref. 65a).

(2) The most common chemical warfare agents are the nerve agents, GA (Tabun), GB (Sarin), GD (Soman), GF, and VX; and the blister agents, HD (sulfur mustard) and HN (nitrogen mustard) and the arsenical vesicants, L (Lewisite). Other toxic chemicals such as hydrogen cyanide (characterized as a chemical blood agent by the military) are included in Chapters 3 and 8, Toxic Industrial Chemical (TIC) Terrorism. There are also toxic chemicals derived from living organisms, generically termed toxins. Toxins are included in Chapters 1 and 6, Biological Warfare Agent (BWA) Terrorism.

(3) Nerve agents inhibit acetylcholinesterase enzyme throughout the body, notably in the nervous system, causing hyperactivation of cholinergic pathways, causing convulsive seizures and respiratory failure (among many other signs and symptoms) (Ref. 51). Vesicants cause irritation and vesication (blistering) of the skin and mucous membranes, notably the lungs (Ref. 51). Mustard exposure to the skin is insidious, causing no immediate discernable effects to the skin for several hours; blistering occurs 12-24 hours after exposure (Ref. 51). Although mustard causes few deaths, its vesicating properties are incapacitating, and casualties require 1 to 4 months of hospitalization (Ref. 51).

(4) The volatility of a chemical agent often determines how it is used. Volatility refers to a substance's ability to become a vapor at a relatively low temperature (Ref 65a). A

highly volatile (nonpersistent) substance (e.g., Sarin) poses a greater respiratory hazard than a less volatile (persistent) substance (e.g., VX). Because a persistent substance may remain on the skin for a longer period of time (because of the relatively slower evaporation rate of persistent agents), it may pose a greater local skin hazard (e.g., mustard) or have a greater potential to be absorbed through the skin (e.g., VX) than a nonpersistent substance (e.g., Sarin).

2.2. Nerve Agents. This section provides an overview of nerve agents. A discussion of their physical and chemical properties, their routes of entry, and descriptions of symptoms is also provided.

2.2.1. Overview (Ref. 65a). Among lethal chemical agents, nerve agents have had an entirely dominant role since World War II. Nerve agents acquired their name because they affect the transmission of impulses in the nervous system. All nerve agents belong to the chemical group of organophosphate compounds; many common pesticides also belong to this chemical group. Nerve agents are stable, easily dispersed, highly toxic, and have rapid effects when absorbed both through the skin and the respiratory system. Nerve agents can be manufactured by means of fairly simple chemical techniques. The raw materials are inexpensive but some are subject to the controls of the Chemical Weapons Convention and the Australia Group Agreement.

2.2.2. Physical and Chemical Properties (Ref. 65a). The nerve agents considered in this guide are:

- A. GA: A low volatility persistent chemical agent that is taken up through skin contact and inhalation of the substance as a gas or aerosol.
- B. GB: A volatile nonpersistent chemical agent mainly taken up through inhalation.
- C. GD: A moderately volatile chemical agent that can be taken up by inhalation or skin contact.
- D. GF: A low volatility persistent chemical agent that is taken up through skin contact and inhalation of the substance either as a gas or aerosol.
- E. VX: A low volatility persistent chemical agent that can remain on material, equipment, and terrain for long periods. Uptake is mainly through the skin but also through inhalation of the substance as a gas or aerosol.

Nerve agents in the pure state are colorless liquids. Their volatility varies widely. The consistency of VX may be likened to motor oil and is therefore classified as belonging to the group of persistent chemical agents. Its effect is mainly through direct contact with the skin. GB is at the opposite extreme; being an easily volatile liquid (comparable with water), it is mainly taken up through the respiratory organs. The volatilities of GD, GA, and GF are between those of GB and VX.

2.2.3. Route of Entry and Symptoms

A. General. Nerve agents, either as a gas, aerosol, or liquid, enter the body through inhalation or through the skin (Ref. 65a). Poisoning may also occur through consumption of liquids or foods contaminated with nerve agents (Ref. 65a). The route of entry also influences the symptoms developed and, to some extent, the sequence of the different symptoms (Ref. 65a).

B. Inhalation and Local Effects Due to Vapor Contact.

(1) Generally, the poisoning works most rapidly when the agent is absorbed through the respiratory system rather than other routes because the lungs contain numerous blood vessels and the inhaled nerve agent can quickly diffuse into the blood circulation (Ref. 65a). After nerve agent vapor is inhaled, symptoms occur within seconds to several minutes (Ref. 51). The severity of the symptoms after inhaling or local contact with vapors depends upon the vapor concentration (Ref. 51):

- *Low Exposure (local effects, resulting from direct contact with vapor or aerosol)*: miosis; rhinorrhea; slight bronchoconstriction; secretions (slight labored or difficult breathing); reflex nausea and vomiting.
- *Moderate Exposure (local effects, resulting from direct contact with vapor or aerosol)*: same as with low exposure, except moderate to marked labored or difficult breathing and wheezing.
- *High Exposure*: same as with moderate exposure, plus: loss of consciousness; convulsions (seizures); generalized fasciculations; flaccid paralysis; apnea; involuntary micrition/defecation possible.

(2) At low exposures, the eyes, nose, airways, or a combination of these organs are usually affected (Ref. 51). The nose and eyes are the most sensitive organs; the eyes may be affected equally or unequally (Ref. 51). There may be some degree of miosis (with or without pain) with or without rhinorrhea, or there may be rhinorrhea without eye involvement (Ref. 51). Miosis can be seen as the first effect, or the only effect, due to local contact with eyes.

(3) As exposure increases, eye, nose, and lung involvement is usually seen (Ref. 51). The victim may or may not notice dim vision and may complain of “tightness of the chest.” (Ref. 51). “Tightness in the chest” may occur in the absence of physical findings (Ref. 51).

(4) At higher exposures, effects may intensify (Ref. 51). This may include marked miosis, copious secretions from the lungs, nose, and mouth, and signs of moderate-to-severe impairment of breathing (Ref. 51). The victim will complain of mild-to-severe labored or difficult breathing, may be gasping for air, and will have obvious secretions (Ref. 51).

(5) In severe exposures, the victim may notice an increase in secretions and difficulty in breathing; become dizzy; lose consciousness within minutes and exhibit the following symptoms: convulsive jerking motions of the limbs; copious secretions from the lungs, mouth,

and nose; very labored, irregular, and gasping breathing; generalized muscular fasciculations; miosis; flaccid paralysis and apnea (Ref. 51).

(6) It should be noted that symptomatic patients that were exposed to a volatile agent and are removed from the area and improving (and decontaminated if needed), should continue to improve, since the agent is not persistent.

C. Absorption through the skin.

(1) The poisoning works slower when the agent is absorbed through the skin than through the lungs (Ref. 65a). Since nerve agents are somewhat fat-soluble, they can easily penetrate the outer layers of the skin, but it takes longer for the poison to reach the deeper blood vessels (Ref. 65a). The time delay before initial symptoms occur will vary depending on the level of dermal exposure, as will the severity of the symptoms; the higher the dermal exposure level, the sooner the symptoms may appear (Ref. 51). For mild or moderate skin exposure, there may be up to an 18-hour delay before symptoms occur, whereas with severe skin exposure, there may only be a 2-30 minute delay before symptoms occur (Ref. 51). The severity of the symptoms depends upon the level of exposure (Ref. 51):

- *Mild Skin Exposure:* Increased sweating at site; muscular fasciculations at site.
- *Moderate Skin Exposure:* Same as with mild exposure, plus nausea, vomiting, diarrhea, and generalized weakness.
- *Severe Skin Exposure:* Same as for moderate exposure, plus loss of consciousness, convulsions, generalized fasciculations, flaccid paralysis, apnea, generalized secretions, involuntary urination/defecation possible.

(2) The early effects of a drop of nerve agent on the skin and the time of onset of these effects depend on amount of nerve agent and several other factors, such as the site on the body, the temperature, and the humidity (Ref. 51). After a delay during which the individual is asymptomatic, localized sweating occurs at the site of the droplet; less commonly, there are localized fasciculations of the underlying muscle (Ref. 51). Unless the amount of the nerve agent is in the lethal range, the next effects (or perhaps the first effects, if the sweating and fasciculations do not occur or are not noticed) are gastrointestinal: nausea, vomiting, diarrhea, or a combination of these symptoms (Ref. 51). The casualty may notice generalized sweating and complain of tiredness or otherwise feel ill (Ref. 51). There may be a period of many hours between exposure and the appearance of symptoms and signs (Ref. 51). These signs and symptoms might occur even if the casualty has been decontaminated (Ref. 51).

(3) After large exposures, the time to onset of effects may be much shorter than for smaller exposures and decreases as the amount of agent increases (Ref. 51). For instance, two individuals were reported to have been decontaminated within minutes of exposure to a drop of nerve agent (Ref. 51). There was a 15- to 20-minute, asymptomatic interval before the precipitant onset of effects: collapse, loss of consciousness, convulsive muscular jerks,

fasciculations, respiratory embarrassment, and copious secretions (Ref. 51). Within several minutes, flaccid paralysis and apnea occurred in both (Ref. 51).

2.3 Blister Agents (Vesicants). This section provides an overview of blister agents. A discussion of their physical and chemical properties, their routes of entry, and descriptions of symptoms is also provided (Ref. 65a).

2.3.1. Overview. There are two major families of blister agents (vesicants): sulfur mustard (HD) and nitrogen mustard (HN), and the arsenical vesicants (L) (Ref. 65a). All blister agents are persistent and may be employed in the form of colorless gases and liquids (Ref. 65a). They burn and blister the skin or any other part of the body they contact (Ref. 65a). Blister agents are likely to be used to produce casualties rather than to kill, although exposure to such agents can be fatal (Ref. 65a).

2.3.2. Physical and Chemical Properties.

A. Mustard.

(1) In its pure state, mustard agent is colorless and almost odorless (Ref. 65a). It earned its name as a result of an early production method that resulted in an impure product with a mustard-like odor (Ref. 65a). Mustard agent is also claimed to have a characteristic odor similar to rotten onions (Ref. 65a). However, the sense of smell is dulled after only a few breaths so that the smell can no longer be distinguished (Ref. 65a). In addition, mustard agent can cause injury to the respiratory system in concentrations that are so low that the human sense of smell cannot distinguish them (Ref. 65a).

(2) Mustard is an oily liquid and is generally regarded as a “persistent” chemical agent because of its low volatility (Ref. 51). It is very stable during storage (Ref. 65a). In cool weather there is little vapor; however, mustard’s evaporation increases as the temperature increases (Ref. 51). At higher temperatures, such as those in those in the Middle East during the hot season, 100-120 °F, mustard vapor becomes a major hazard (Ref. 51). For example, the persistency of mustard (in sand) may decrease from 100 hours to 7 hours as the temperature rises from 50-100 °F (Ref. 51). Although heat increases the vapor hazard, the rapid evaporation decreases the task of decontamination (Ref. 51).

(3) There were a significant number of casualties among World War I soldiers that were caused by inhaling mustard vapor after sunrise caused significant evaporation of mustard from the ground (Ref. 51). Mustard attacks were frequently conducted at night, and the liquid agent did not readily evaporate in the cool night air (Ref. 51). Several hours after daybreak, however, the sun-warmed air caused the mustard to vaporize (Ref. 51). By this time, thinking the danger from the attack was over, the soldiers had removed their masks; thus they fell victim to the evaporating mustard (Ref. 51). This combination of events produced a significant number of casualties among soldiers (Ref. 51). Because of these nighttime shellings, it soon became standard policy not to unmask for many hours after daybreak (Ref. 51).

(4) Mustard vapor has a density 5.4-times greater than air, causing it to hug the ground and sink into trenches and gullies (Ref. 51). Mustard agent can easily be dissolved in most organic solvents but has negligible solubility in water (Ref. 65a). In aqueous solutions, mustard agent decomposes into nonpoisonous products by means of hydrolysis but since only dissolved mustard agent reacts, the decomposition proceeds very slowly (Ref. 65a). Oxidants such as chloramines, however, react violently with mustard agent, forming nonpoisonous oxidation products (Ref. 65a). Consequently, these substances are used for the decontamination of mustard agent (Ref. 65a).

B. Arsenical vesicants (Ref. 65a). Arsenical vesicants are not as common or as stable as the sulfur or nitrogen mustards. All arsenical vesicants are colorless to brown liquids. They are more volatile than mustard and have fruity to geranium-like odors. These types of vesicants are much more dangerous as liquids than as vapors. Absorption of either vapor or liquid through the skin in adequate dosage may lead to systemic intoxication or death.

2.3.3. Route of Entry (Ref. 65a).

A. Most blister agents are relatively persistent and are readily absorbed by all parts of the body. Poisoning may also occur through consumption of liquids or foods contaminated with blister agents.

B. These agents cause inflammation, blisters, and general destruction of tissues. In the form of gas or liquid, mustard agent attacks the skin, eyes, lungs, and gastrointestinal tract. Internal organs, mainly blood-generating organs (i.e., bone marrow, spleen, and lymphatic tissue), may also be injured as a result of mustard agents being taken up through the skin or lungs and transported into the body.

C. Since mustard agents give no immediate symptoms upon contact, a delay of between 2 to 24 hours may occur before pain is felt and the victim becomes aware of what has happened. By then, cell damage has already occurred. The delayed effect is a characteristic of mustard agent.

2.3.4. Symptoms.

A. In general, vesicants can penetrate the skin by contact with either liquid or vapor. The latent period for the effects from mustard is usually several hours (the onset of symptoms from vapors is 4 to 6 hours and the onset of symptoms from skin exposure is 2 to 48 hours). There is no latent period for exposure to Lewisite.

B. Mild symptoms of mustard agent poisoning may include a gritty sensation of the eyes with excessive tearing, inflammation of the skin, irritation of the mucous membranes, hoarseness, coughing, and sneezing. Normally, these injuries do not require medical treatment.

C. Severe injuries that are incapacitating and require medical care may involve eye injuries with loss of sight, the formation of blisters on the skin, nausea, vomiting, and diarrhea together with severe difficulty in breathing. Severe damage to the eye may lead to the total loss of vision.

D. The most pronounced effects on inner organs are injury to the bone marrow, spleen, and lymphatic tissue. This may cause a drastic reduction in the number of white blood cells 5 to 10 days after exposure; a condition very similar to that after exposure to radiation. This reduction of the immune defense will complicate the already large risk of infection in people with severe skin and lung injuries.

E. The most common cause of death as a result of mustard agent poisoning are complications (typically pneumonia) after lung injury caused by inhalation of mustard agent. Most of the chronic and late effects from mustard agent poisoning are also caused by lung injuries.

2.4. References for Further Details.

- USAMRICD Medical Management of Chemical Casualties Handbook, Third Edition, July 2000. Website link: http://ccc.apgea.army.mil/reference_materials/handbooks/RedHandbook/001TitlePage.htm
- MMCC Supplemental Training Materials v. 3.00 CD-ROM, Chemical Casualty Care Division, USAMRICD, January 2002.
- Textbook of Military Medicine, Part I, Volume 2, Medical Aspects of Chemical and Biological Warfare, Office of the Surgeon General, Department of the Army, 1997. Website link: <http://www.nbc-med.org/SiteContent/HomePage/WhatsNew/MedAspects/contents.html>
- Chemical Warfare Agents and Associated Health Guidelines, <http://chppm-www.apgea.army.mil/hrarcp/CAW/toc.html>. This website includes information and links to sites that provide information on basic chemical, physical, and toxicological properties of CWA.
- US Chemical-Biological Defense Guidebook, Jane's Information Group, 1997.
- CDC Chemical Agent Website, <http://www.bt.cdc.gov/agent/agentlistchem.asp>

SECTION I: BACKGROUND INFORMATION

CHAPTER 3: TOXIC INDUSTRIAL CHEMICAL TERRORISM

3.1. General.

3.1.1. Introduction.

- A. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.
- B. A list of references cited in this Chapter can be found in Appendix B.
- C. Selection of PPE is discussed in Section II. Chapters 5 and 8 of Section II discuss PPE selection issues relevant to Toxic Industrial Chemical (TICs) terrorism.
- D. Program requirements for PPE use are discussed in Section III.
- E. A list of TICs are presented in Appendix H.

3.1.2. Definition and Overview of TICs.

A. General (Ref. 65a). TICs are chemicals other than chemical warfare agents (Chapter 2) that have harmful effects on humans. TICs, often referred to as toxic industrial materials (TIMs) are used in a variety of settings such as manufacturing facilities, maintenance areas, and general storage areas. See Appendix H for a list of TICs.

B. TIC Hazard Rankings are based on Toxicity and Production Quantity (Ref. 65a).

(1) A TIC is a *specific type* of industrial chemical, i.e., one that has a LC₅₀ value by inhalation less than 100,000 mg-min/m³ in any mammalian species and is produced in quantities exceeding 30 tons per year at one production facility.

(2) Although they are not as toxic as the highly toxic nerve agents, their ability to make a significant impact on the populace is assumed to be more related to the amount of chemical a terrorist can employ on the target(s) and less related to their lethality.

(3) None of these compounds are as highly toxic as the nerve agents, but they are produced in very large quantities (multi-ton) and are readily available; therefore, they pose a far greater threat than chemical warfare agents. For instance, chlorine is not as toxic as the nerve agents, but it is easier to disseminate large quantities of chlorine because large amounts of it are manufactured and transported everyday. It is assumed that a balance is struck between the lethality of a material and the amount of materials produced worldwide.

(4) Materials such as the nerve agents are so toxic as to be in a special class of chemicals. Since TICs are less toxic than the highly toxic nerve agents, it is more difficult to determine how to rank their potential for use by a terrorist.

3.2. Hazard Rankings of TICs (Ref. 65a).

A. TICs are ranked into one of three categories (high, medium, or low hazard) that indicate their relative importance and assist in hazard assessment. Appendix H provides a list of TICs as extracted from the Reference 65a.

B. High hazard indicates a widely produced, stored or transported TIC that has high toxicity and is easily vaporized.

C. Medium hazard indicates a TIC, which may rank high in some categories but lower in others such as number of producers, physical state, or toxicity.

D. Low hazard indicates that this TIC is not likely to be a hazard unless specific operational factors indicate otherwise.

3.3. Physical States of TICs.

The TICs identified in Appendix H may be in a liquid, vapor, or gas state, depending upon the chemical and circumstances.

3.4. Symptoms and Health Effects as a Consequence of TIC Exposure.

A. Gas and vapor exposure.

(1) The biggest concern would generally be from inhaling the gas or the vapor (from the liquid) or local effects (e.g., irritation) of the vapors or gasses on the eyes or skin. Local effects could include irritation of the eyes, nose, throat, or conducting airways (tracheobronchial region) of the lung or the deep lung (pulmonary region) where gas exchange takes place. Other TICs may have systemic effects after being inhaled and being absorbed into the blood, and could result in effects on the central nervous system, cardiovascular system, reproductive system, blood, kidneys, or liver.

(2) Exposures would be greatest the closer one is downwind to the incident site. Depending on the chemical, exposure concentration, and exposure duration, health effects could range from mild to severe, and in some instances could result in irreversible health effects or even death.

(3) Gases would not pose a potential hazard to those at the MTF unless the MTF is part of the incident site. Vapors would not pose a potential hazard to those at the MTF unless the

MTF is part of the incident site or if patients arrive that are still physically contaminated with the liquid.

(4) Exposure to many of the TICs may result in irritation to the eyes and upper respiratory tract (nose and throat), and the irritation may be severe depending upon the chemical and the exposure concentration. If the exposure concentration is high enough, symptoms could include a burning sensation or tearing of the eyes, burning sensation in the throat, or coughing.

(5) High-level exposures to some of the TICs may cause dizziness, headaches, nausea, vomiting, or loss of consciousness.

(6) Some TICs may cause chest pain or difficulty in breathing if the airborne concentration is high enough and the exposure duration is long enough. For instance, some high level exposures to some TICs may cause asphyxiation by displacing oxygen or by chemical reactions within the body, making it difficult to breathe and possibly even resulting in death if exposures are very high. Other TICs may cause a serious life-threatening effect to the respiratory system, such as delayed pulmonary edema, if the exposure is great enough.

(7) Exposure to some TICs may result in cancer at some distant point in the future.

B. Liquid exposure. Some of the liquids are very corrosive to the skin and eyes and require immediate decontamination; otherwise, severe damage to these organs may result. Some of the chemicals may also be absorbed through the skin in significant amounts if the liquid contacts the skin in large enough amounts and for long enough duration. For these chemicals, immediate decontamination is also critical; otherwise toxic systemic effects may result. Patients arriving at the MTF that are physically contaminated with a liquid TIC may present a potential skin, eye, or inhalation hazard to other personnel at the MTF.

C. References to consult for specific toxic effects and symptoms of TICs. References 19, 21, 23, and 102 should be consulted for the toxic effects and symptoms that may result from exposure to the TICs listed in Appendix H. Also, the CDC Chemical Agent Website contains toxic effects and symptoms for some TICs, <http://www.bt.cdc.gov/agent/agentlistchem.asp>

3.5. Potential Terrorist Targets and Associated Risks.

A. Potential terrorist targets include TICs in storage, production, distribution or transportation. Individual localities should assess their specific vulnerabilities, which depend on nearby industrial, storage, or transportation (e.g., rail, truck, etc.) lines, etc.

B. The risks from TICs is not only linked to the risk from a single chemical compound but from risks that result from explosion, fires and the associated combustion by-products.

SECTION I: BACKGROUND INFORMATION

CHAPTER 4: NUCLEAR AND RADIOLOGICAL TERRORISM

4.1. General.

4.1.1. Introduction.

- A. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.
- B. A list of references cited in this Chapter can be found in Appendix B. Section 4.2 contains a list of references for further details.
- C. Selection of PPE is discussed in Section II. Chapters 5 and 9 of Section II discuss PPE selection issues relevant to Nuclear and Radiological terrorism.
- D. Program requirements for PPE use are discussed in Section III.

4.1.2. General Principles.

- A. The MTF radiation protection officer (RPO) shall be notified as soon that it is suspected that contaminated casualties will be arriving. Radiation dosimeters should be assigned by the RPO or other appropriate person IAW MTF policy.
- B. It must be noted that radioactive contamination (whether internal or external) is typically not life threatening and therefore, a radiological assessment or decontamination should never take precedence over significant medical conditions.
- C. PPE and dosimeters will not protect personnel from external gamma and neutron exposure.
- D. Use the principles of time, distance, and shielding to reduce your radiation exposure (see Section 4.1.8.C(3), p. 32).
- E. Understand your potential working conditions; for example, number and condition of expected casualties. Be alert to health and safety issues.

4.1.3. Radiological Sources of Potential Exposure and/or Contamination. USACHPPM Technical Guide 238 (*Radiological Sources of Potential Exposure and/or Contamination*) contains a comprehensive discussion of radioactive materials. This technical guide can be found at <http://chppm-www.apgea.army.mil/documents/TG/TECHGUID/Tg238.pdf>.

4.1.4. Radiation Threat Scenarios.

A. General. Radioactive material will be dispersed by either the use of any nuclear weapon or radiation dispersal device (RDD) (i.e., “dirty bomb”), destruction of a nuclear reactor, a nuclear accident, or improper nuclear waste disposal (Ref. 55). These materials may exist in the atmosphere, deposited on surfaces, or suspended in the air. Persons in these contaminated areas could receive sufficient radiation exposure or particulate contamination to warrant medical evaluation and decontamination (Ref. 55). Casualties contaminated with radionuclides would complicate medical evacuation within the contaminated area. Terrorists might also target radioactive materials (solids, liquids, or gasses) while carried during distribution and transportation, creating a HAZMAT Incident.

B. Radiological Dispersal Device (RDD). An RDD (for example “dirty bomb”) is a device that causes the purposeful dissemination of radioactive material across an area without a nuclear detonation (Ref. 55). Such a weapon can be easily developed and used by a terrorist with explosives (or other means of dissemination) and access to radionuclides. The material dispersed can originate from any location that uses radioactive sources, such as a nuclear waste processor, a nuclear power plant, a university research facility, a medical radiotherapy clinic, or an industrial complex. The radioactive source is dispersed using explosives (or other means; e.g., crop-dusting aircraft).

C. Nuclear weapons (Ref. 132)

(1) The most likely terrorist nuclear weapons scenario involves the use of a single (probably low-yield) nuclear device (< 10 kT). Although catastrophic, the availability of resources from the state, federal government, and even the international community, make the consequences of this kind of disaster manageable.

(2) The detonation of a low-yield nuclear weapon in a populated area will cause large numbers of casualties with combined injuries. Of primary importance to MTF personnel engaged in early stage medical management, would be the logistics involved in evacuating casualties to available medical centers.

4.1.5. Types of Ionizing Radiation.

A. Alpha particles. Alpha particles are positively charged with a mass about four times that of a neutron. Because of the mass and charge of the alpha particles, they cannot travel far and are fully stopped by the dead layers of the skin or by PPE. Alpha particles are not an external (on or outside the human body) hazard. When they are emitted from internalized (inhaled, ingested, imbedded, or enter through open wounds) radioactive materials, alpha particles cause significant cellular damage in the region immediately adjacent to their physical location. If appropriate PPE is properly worn, it will prevent or reduce the risk of internalizing radioactive materials.

B. Beta particles. Beta particles are negatively charged particles and travel a short distance in tissue. Beta-emitting contamination can produce damage to the basal stratum of the

skin. This resulting damage (commonly referred to as a “beta burn”) can appear similar to a thermal burn. PPE worn by first responders or MTF personnel will protect against all but the most energetic beta particles; also, if properly worn, PPE will prevent or reduce the risk of internalizing radioactive materials.

C. Neutrons. Neutrons are uncharged particles that interact with the nuclei of atoms. Neutrons are emitted during nuclear detonation and would not be a fallout hazard to response personnel at the incident site. A neutron-emitting source can be used as part of an RDD.

D. Gamma and X-rays. Gamma rays are electromagnetic, not particulate, radiation and are uncharged and similar to x-rays. They are emitted from many natural materials, radioactive fallout, and during a nuclear detonation. Gamma radiation has high penetrability and can result in whole-body exposure.

4.1.6. Radioactive Material, and Contamination Following a Terrorist Attack.

A. Radiological Dispersal Devices (Ref. 132)

(1) The most likely scenarios involve the use of a solid radioactive material that would be of low enough activity that the construction and delivery of the RDD will not seriously inhibit the terrorist from carrying out the attack. Large sources of penetrating radiation *are* difficult to handle safely and without detection by authorities. Shielding materials that are adequate to protect both the individuals who construct these devices and those who are to deploy them complicates the design and fabrication of effective weapons. Although not insurmountable, these challenges can only be overcome with considerable technical expertise and sophisticated resources.

(2) Although the most likely devices involve a high explosive coupled with a solid, usually pellets or powder, the radioactive material could also be in some kind of solution, or even be a radioactive gas.

B. Nuclear Weapon

(1) *Initial Radiation (Ref. 132)*. The detonation of a nuclear weapon produces an initial intense pulse of ionizing radiation. Both gamma rays and neutrons are released. The radiation produced in the first minute post-detonation is termed *initial radiation*, and that resulting from the decay of radioactive materials after the first minute is termed *residual radiation*.

(2) *Residual Radiation (Ref. 132)*. Residual nuclear radiation is defined as the ionizing radiation that is emitted after the initial intense pulse of radiation from the detonation of a nuclear weapon. This includes the significantly increased levels near the site of detonation caused mostly by the radioactive weapon debris, fission products, as well as the activation of soil and other materials by components of the initial radiation.

(3) *Fallout and other Radioactive Material.* Fallout is that radioactive material produced by a nuclear detonation and includes fission products, activation products, and remains of the original weapon. Nuclear fallout may adhere loosely to surfaces in the form of dust, ashes, dirt, or mud (Ref. 56).

4.1.7 Biological Effects of Ionizing Radiation.

A. Definitions (Ref. 132). A variety of terms are used to describe and categorize the effects of ionizing radiation. First, the time period over which effects are manifested can be described by the terms early and late. **Early effects** generally refer to the consequences of the exposure that are expressed within a period of a few days to a few months. **Late effects** refer to the long-term consequences of the exposure and include effects that may not be expressed for many years. A second set of terms, acute and chronic are used to describe the period of time over which an individual is exposed. Generally an **acute exposure** refers to an exposure received within a period of a few hours or less and a **chronic exposure** generally refers to exposures received over several days or longer. It is important to recognize that both acute and chronic exposures can give rise to both early and late effects.

B. Radiological quantities and units (Ref. 132). The quantities and their associated units used in the radiological sciences are divided into two categories: those considered fundamental and those that are derived from the fundamental quantities for specific applications (e.g., radiation protection). The most important fundamental quantity is **absorbed dose**, defined as the quotient of $d\epsilon$ by dm where $d\epsilon$ is the mean energy imparted by ionizing radiation to the matter in a volume element and dm is the mass of the matter in that volume element, i.e. the absorbed dose $D = d\epsilon/dm$. The unit of absorbed dose is the joule per kilogram ($J\ kg^{-1}$) and is given the special name, gray (Gy).

(1) *Derived quantities.* A quantity derived from the absorbed dose and used for radiation protection purposes is the **dose equivalent**, defined as the product of a dimensionless quality factor, and the absorbed dose to tissue at a specific point. A quality factor is chosen to weight the absorbed dose by the biological effectiveness of the charged particle spectrum at the point in tissue where the absorbed dose is determined. The unit of dose equivalent is the joule per kilogram ($J\ kg^{-1}$) and is given the special name, sievert (Sv).

(2) *Absorbed dose rate.* The absorbed dose rate has an important impact on radiation damage and personnel hazard. Cells have the capacity to repair injury to their genetic material and, at low absorbed dose rates, these repair mechanisms can decrease the frequency of lethal and nonlethal injuries to the cell. This is an extremely important consideration for emergency response personnel because of the impact on risk and because most exposure scenarios confronted by emergency response personnel following the initial event involve protracted exposure. More practically, the absorbed dose rate will determine the amount of time a person may remain in an area without incurring unacceptable long-term risks of adverse health effects. **It is essential that before emergency response personnel enter an area of elevated exposure, the anticipated exposure be justified in terms of the objectives to be accomplished. In addition, these personnel should be provided with radiation detection equipment that can**

be used to assess personnel exposures, identify types of radiation, and establish the boundaries of the contaminated areas.”

C. Stochastic and deterministic effects (Ref. 132). The biological effects of ionizing radiation can be categorized as being either deterministic or stochastic. **Deterministic effects** are those that are assumed to have a threshold (i.e., an exposure level below which the effect is not observed) and whose severity increases with the exposure level. In contrast, stochastic effects are those that are assumed not to have a threshold and whose severity does not depend on the exposure level. Skin reddening (erythema) is an example of a deterministic effect because it has a threshold of approximately 5 to 6 Gy with increasing severity for larger exposures. (An earlier skin reddening response can occur at lower absorbed doses (2 Gy) within a few hours of the exposure. This is caused by damage to the superficial capillaries and generally resolves within 2 days.) Skin reddening is also an early effect because it is usually expressed within two to four weeks after the exposure. Cancer caused by ionizing radiation is an example of a **stochastic effect** because it is assumed to have no threshold and because the severity of the cancer, once it occurs, is independent of the exposure. Cancer is also an example of a late effect because there is a long period of time, usually many years, between the exposure and the expression of the disease.

D. Biological effects of radiation exposure. The health effects of ionizing radiation depend largely on the absorbed dose, the absorbed dose rate, and the organs or tissues that have been exposed (Ref. 132). Radiation damage to the cell's genetic material [deoxyribonucleic acid (DNA) and mitotic apparatus] can cause cell death or, if damaged cells survive, can result in altered cell or tissue function (Ref. 132). For example, death of bone marrow stem cells can result in low platelet, white and red blood cell counts and, consequently, a high susceptibility to infection and bleeding. Damaged DNA in surviving cells can cause mutations in the cells and an increased risk of cancer (Ref. 132).

(1) Early effects.

(A) General.

- Nonlife-threatening effects include temporary or permanent sterility, depression of rapidly proliferating cell types (e.g., bone marrow stem cells), vomiting, skin reddening, hair loss, and cataracts (Ref. 132). Table 4.1 provides estimates of acute exposure thresholds for these effects (Ref. 132). In general, thresholds are higher if the exposure is protracted over periods of time greater than a few hours (Ref. 132).

- The acute radiation syndrome is a broad term used to describe a range of signs and symptoms that reflect severe damage to specific organ systems and that can lead to death within hours or up to several months after exposure (Ref. 132). The nature of these injuries, the time at which they are expressed, and often the duration are a function of the absorbed dose and the rate at which it is received by the individual (Ref. 132).

(B) Hematopoietic syndrome (Ref. 56): appears within two weeks after biologically significant radiation doses of 1.0-2.5 grays (Gy). This damage to the body's blood-

forming organs, specifically the bone marrow, can lead to suppressed production of white blood cells and platelets, which in turn leads to increased susceptibility to infection and uncontrolled bleeding.

(C) Gastrointestinal syndrome (Ref. 56): appears within a week or two after exposure to higher doses, which are sometimes survivable. After this exposure, crypt cells in the epithelial lining of the intestine are destroyed. This leads to excessive loss and imbalance of electrolytes within the body, which may result in loss of the intestinal wall.

(D) Pulmonary syndrome: it may appear within two to five weeks of an acute exposure.

(E) Neurovascular syndrome (Ref. 56): appears within a few days after much higher doses of radiation, and consists of irreversible damage to the central nervous system.

Table 4-A. Estimates of Threshold Doses for Deterministic Effects of Acute Radiation Exposure (Ref. 133)

Health Effect	Organ	Absorbed Dose (Gy)
Temporary sterility	Testis	0.15
Nausea		0.35
Depression of blood cell forming process	Bone marrow	0.5
Reversible skin effects (e.g., early reddening)	Skin	2
Permanent sterility	Ovaries	2.5 – 6
Vomiting		3
Temporary hair loss	Skin	3 – 5
Permanent sterility	Testis	3.5
Skin erythema	Skin	5 – 6
The absorbed doses reported in this table refer only to exposures to low-LET radiation (i.e., x rays, gamma rays, or energetic electron beams).		

(2) *Late effects* (Ref. 132). The most important late effect of radiation exposure is the induction of a fatal cancer. Ionizing radiation can induce either benign or malignant tumors, which are generally described as stochastic effects. These are effects without an assumed threshold and for which increasing the absorbed dose to the individual increases the probability of a cancer, but has little or no effect on its severity.

(A) Contrary to public perception, ionizing radiation is a relatively weak carcinogen. As an example, among the approximately 86,000 atomic-bomb survivors at Hiroshima and Nagasaki who have been studied from 1950 to 1990, there has been an excess of only 334 deaths from solid cancer (7,578 versus 7,244 expected) and there have only been 87 excess deaths from leukemia (249 versus 162 expected). Epidemiology studies of these populations continue and a small excess of cancers and some other diseases is still being detected more than 50 years after exposure, especially among people who were young when irradiated. Although many types of human tumors can be induced by radiation exposure, the sensitivity of

specific tissues to cancer induction by radiation varies significantly, and a few types of neoplasms do not appear to be radiation induced (e.g., chronic lymphocytic leukemia). Once a radiogenic tumor occurs in a given individual, it is clinically and pathologically indistinguishable from tumors due to other causes.

(B) Cancer, including leukemia, has been clearly linked with exposure to ionizing radiation, and is likely the most important effect at absorbed dose levels below 1 Gy. Over the last five decades, thousands of papers on radiation carcinogenesis have appeared in the scientific literature.

(3) *Other late effects (Ref. 132).* Other late effects of concern include (1) severe **genetic (hereditary) effects** expressed in subsequent generations and (2) other causes of **noncancer mortality** associated with exposure to ionizing radiation. The irradiation of the gonads of either parent has not been shown to result in deleterious effects on children. Over the last three decades, it has become clear that the risks of transmitting such radiation-acquired abnormalities to offspring have been difficult or impossible to identify. At higher absorbed doses, there are very few populations of large enough size to allow risk estimation. As a result, human risk estimates have been based largely on analyses of animal data. The NCRP has endorsed a risk coefficient for severe genetic effects of $1 \times 10^{-2} \text{ Sv}^{-1}$ for a population of all ages exposed to low absorbed doses and absorbed-dose rates.

(A) The category “other causes of noncancer mortality” includes diseases of the circulatory, digestive and respiratory systems. Statistically significant increases in mortality attributable to these diseases have been observed in the atomic-bomb survivors. Although there are insufficient data to determine a dose-response relationship, the current data appear to show a curvilinear shape with essentially zero risk below 0.5 Sv. The relative increase in the mortality rate for these diseases for individuals exposed to 1 Sv is approximately 10 percent.

(4) *In Utero* (within the uterus) effects (Ref. 132). Throughout most of a pregnancy, the fetus is assumed to be at risk for potential carcinogenic effects of radiation. From the third week after conception until delivery, there is felt to be an increased risk of both leukemia and childhood cancer. The magnitude of the risk has been the subject of many publications, yet their interpretation remains open to debate. There is some evidence of elevated numbers of leukemias among atomic-bomb survivors who were irradiated *in utero* but there is no apparent dependence on absorbed dose and the cases did not occur during childhood.

(5) *Fetal Development (Ref. 132).* Fetal absorbed doses in the range below 0.1 Gy appear to present no substantial risk of fetal death, malformation or impairment of mental development. In addition, the lifetime risk of radiogenic induction of childhood cancer or leukemia at 0.1 Gy is about 1 in 170. Accordingly, the ICRP has concluded that there is no medical justification for terminating a pregnancy at fetal absorbed doses below this level.

4.1.8. Internal and External Radiation – Routes of Exposure and Preventive/Protective Measures.

A. General (Ref. 132). To minimize their risks from exposure to ionizing radiation, all on-scene personnel should carry out their responsibilities keeping in mind three principles to minimize exposure. First, minimize time spent in a radiological environment. Second, maintain the maximum distance from sources of radiation. Third, whenever possible, use shielding to reduce exposure. ***All personnel responding to the scene of a radiological incident should be given a personal dosimeter and should wear appropriate clothing that will minimize contamination.*** Medical personnel who will be handling potentially contaminated patients should wear surgical gloves and appropriate anti-contamination clothing. Disposable gowns are particularly useful for medical personnel because they can be easily and quickly changed if necessary as they move from patient to patient.

B. Internal radiation.

(1) *Routes of exposure (Ref. 132).* Radioactive material can enter the body by eating or drinking contaminated foods or fluids, through skin or a wound, and by breathing radioactive gases or aerosols. A radioactive material taken into the body will distribute through physiological processes determined by its chemical and physical properties. Radioactive materials that remain on the surface of the skin are considered sources of external exposure if they do not enter the body. However, while on the skin, they can be inhaled, ingested, or enter the body through a break in the skin [or be absorbed through the skin].

(2) *Preventive/Protective measures. (See Chapter 9.)*

(A) Personnel with the potential to be contaminated should wear proper PPE (Ref. 132). This should virtually eliminate the inhalation or inadvertent ingestion of radionuclides and prevent radionuclides from contacting the skin and entering the body (Ref. 132). Careful personnel decontamination will greatly reduce the gross radiation absorbed dose to contaminated people (Ref. 132).

(B) Good personnel hygiene and standard hospital barrier clothing will reduce the amount of contamination that is inadvertently ingested. For example, smoking, drinking, eating only in uncontaminated areas, and thoroughly washing hands upon leaving potentially contaminated areas will reduce the radiation dose to responders.

(C) Workers [health care and first responders] should also be selected on the basis of their experience in performing required emergency tasks because the time to accomplish a task will likely be reduced, thus helping to minimize worker exposure (Ref. 132). The number of workers involved in such tasks should be kept as low as strictly necessary for the tasks to be carried out. Only nonpregnant workers over the age of eighteen should be selected (Ref. 132).

C. External radiation.

(1) *Route of exposure.* External radiation refers to the ionizing radiation from radiation sources outside the human body. Sources of external radiation include contamination in the environment, discrete radioactive sources, fallout, contaminated victims, contaminated response equipment, and activation products. Response personnel may become contaminated themselves by interacting with the contaminated patients, either at the incident site or at the MTF, and may be a secondary source of external radiation.

(2) *Contamination on living patients will not normally present a significant external radiation hazard to health care providers.* However, casualties with large amounts of radioactive material imbedded in a wound may warrant special attention because activated metal can contain radionuclides with very high specific activities, and there may be a significant exposure hazard to treatment personnel (Ref. 132).

(3) *Ways of reducing external radiation dose.* All on-scene personnel should carry out their responsibilities keeping in mind these three principles: first, minimize the time spent in a radiation field; second, maintain the maximum practicable distance from sources of radiation; third, whenever possible use shielding to reduce exposure.

(4) *Effectiveness of PPE against external radiation.* PPE will not protect first responders and MTF personnel from external gamma and neutron exposure. PPE will protect first responders and MTF personnel from external alpha particles and all but the most energetic beta particles.

(5) *Measuring external radiation levels.* Emergency responders or response vehicles likely to be the first to respond to a scene for which there is the potential for radioactive contamination (including the site of any explosion) should be equipped with radiation detectors that will alert the responders to the presence of radiation above action levels IAW command guidance (Ref. 132). Likewise, all MTFs likely to receive people who may be contaminated should have appropriate radiation detectors and trained personnel. The radiation protection officer should be notified as soon that it is suspected that contaminated casualties will be arriving.

(6) *External radiation action levels at the incident site.* As stated in the previous paragraph, action levels for external radiation are to be set IAW command guidance. The following guidance from the National Council on Radiation Protection and Measurements (NCRP) can be used as a starting point for setting action levels for MTF personnel at the incident site. The NCRP recommends that an ambient dose rate of approximately 0.1 mSv h^{-1} is a suitable initial alarm level (Ref. 132). This is a value significantly higher than natural background so that false positive indications are avoided, but not so high that an emergency responder is likely to receive an exposure that would approach the annual limit for a member of the general public if exposed in areas below this value (Ref. 132). It is also an ambient dose rate at which it would be appropriate to establish an initial control point to restrict access for radiological control purposes to any unnecessary persons (Ref. 132). The second alarm level, the “turn-around” level, is necessary to permit this initial emergency response team to perform additional time-sensitive,

critical missions beyond the point where it is recognized that there is a radiological component to the disaster (Ref. 132). The NCRP recommends an ambient dose rate and ambient dose for this purpose would be approximately 0.1 Sv h^{-1} or 0.1 Sv (Ref. 132). It is essential, however, that initial responders not proceed beyond the point at which the initial alarm level has been reached unless there is a compelling reason to do so (Ref. 132). Such reasons include the rescue of injured persons and time-sensitive actions to regain control of the scene (Ref. 132). However, if the first responders include personnel with radiation health expertise and more sophisticated equipment, it is more appropriate that judgments involving higher exposures be made at the scene taking into account all the relevant factors specific to the conditions at the scene (Ref. 132).

(6) *External radiation action levels at the MTF.* Victims arriving at the MTF with contamination greater than natural background levels must be decontaminated.

4.2. References for Further Detail.

- Medical Management of Radiological Casualties Handbook, First Edition, Armed Forces Radiobiology Research Institute, December 1999. Website hyperlink: <http://www.afri.usuhs.mil/www/outreach/training.htm>
- TG 238, June 1999, *Radiological Sources of Potential Exposure and/or Contamination*, Management of Terrorist Events Involving Radioactive Material, USACHPPM, Aberdeen Proving Ground, MD, <http://chppm-www.apgea.army.mil/documents/TG/TECHGUID/Tg238.pdf>
- Radiation Emergency Assistance Center Guidance. The Radiation Emergency Assistance Center has written guidance for those responding both at the scene of an emergency (prehospital) and at the hospital. Website hyperlink: <http://www.orau.gov/reacts/guidesitemap.htm>
- *Management of Terrorist Events Involving Radioactive Material*, NCRP Report Number 138, National Council on Radiation Protection and Measurements, Bethesda MD, 2001.

SECTION II: PPE SELECTION

CHAPTER 5: INTRODUCTION AND GENERAL PPE SELECTION INFORMATION

5.1. General.

5.1.1. Acronyms and terms. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

5.1.2. References. A list of references cited in this Chapter can be found in Appendix B. Also, in the last paragraph of this Chapter, links are provided to National Institute for Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) websites that provide general references regarding personal protective equipment (PPE) selection.

5.1.3. Background information. Background information on potential terrorist agents is provided in Section I (Chapters 1-4). Chapter 1 concerns biological warfare agent (BWA) terrorism. Chapter 2 concerns chemical warfare agent (CWA) terrorism. Chapter 3 concerns toxic industrial chemical (TIC) terrorism. Chapter 4 concerns nuclear and radiological terrorism.

5.1.4. Program requirements. Program requirements for PPE use are discussed in Section III.

5.1.5. Standard Precautions. The PPE recommended herein is in addition to Standard Precautions (paragraph 5.3).

5.1.6. Pictures of PPE Levels and Respirators.

A. PPE Levels. On the cover page, there is a picture of a simulated decontamination of a victim at an incident site. Personnel in Level A PPE have delivered a non-ambulatory victim from the exclusion zone to two people performing decontamination in Level B PPE in the decontamination reduction zone. Level C PPE would look similar to Level B PPE except an air-purifying respirator (APR) is worn instead of an atmosphere-supplying respirator, such as the Self-Contained Breathing Apparatus (SCBA) worn by those in this picture.

B. Respirators. Figures 13-A and 13-B provide pictures of APRs and atmosphere-supplying respirators, respectively.

5.1.7. Selection of PPE. Selection of PPE is discussed in this Section (Section II, Chapters 5-9). Chapter 5 provides an introduction and general PPE selection information for terrorism agents. PPE quick selection summary guidelines are provided in paragraph 5.1.8, Tables 5-A through 5-I, which provide an overview of PPE selection guidance, as well as advantages and disadvantages of different types of respirators – before selecting or procuring PPE, these tables must be consulted before reading other portions of this document. Chapter 6 provides PPE selection guidance specific to BWA terrorism. Chapter 7 provides PPE selection guidance to CWA terrorism. Chapter 8 provides PPE selection guidance specific to TIC terrorism. Chapter 9 provides PPE selection guidance specific to Nuclear and Radiological terrorism.

5.1.8. PPE Quick Selection Summary Guideline Tables.

PPE quick selection summary guideline tables are provided in the following tables (Tables 5-A through 5-I), which provide an overview of PPE selection guidance, as well as advantages and disadvantages of different types of respirators – before selecting or procuring PPE, these tables must be consulted before reading other portions of this document.

Table 5-A: Handling Patients Inside the MTF

Terrorist Agent	Guidelines (including PPE)
<i>BWA: diseases</i>	
VHFs (Viral hemorrhagic fevers)	• Standard, Contact, and Airborne Precautions with any patient with suspected or documented VHF, to include NIOSH-approved N95 particulate respirator; goggles or face shield; an <u>impermeable</u> gown; <u>double</u> gloves; <u>shoe and leg</u> covers; and, head covers. Note: Lassa, Congo-Crimean HF, Ebola, and Marburg viruses may be particularly prone to aerosol nonsocomial spread. • Only Standard Precautions are necessary for some HFs (e.g., Yellow Fever and Dengue HF).
Smallpox	• Standard, Contact, and Airborne Precautions. • NIOSH-approved N95 particulate respirator • Wear appropriate barriers (e.g., gloves, gown, and respiratory protection) when handling items potentially contaminated by infectious lesions.
Plague	• Bubonic plague: Standard Precautions. • Pneumonic plague: Standard Precautions; Droplet Precautions (until the patient has completed 72 hours of antimicrobial therapy). Goggles or a face shield should be worn to prevent expelled respiratory droplets (e.g., from coughing, sneezing, etc.) from contacting the eyes.
• Glanders • Tularemia • Anthrax • Venezuelan Equine Encephalitis • Brucellosis • Q Fever • Botulism • Staph Enterotoxin B • Ricin • T-2 Mycotoxins	• Standard Precautions
Cholera	Standard Precautions. Also use Contact Precautions for diapered or incontinent children < 6 years of age for duration of illness.
Clinical/Diagnostic Laboratory	• Biosafety in Microbiological and Biomedical Laboratories, 4th Edition, CDC/NIH • Smallpox Response Plan & Guidelines, CDC
Post-Mortem Examinations (Autopsies) on Infectious Patients	• As a general precaution, Standard, Contact, and Airborne Precautions should be used. When generating infectious aerosols, use a powered air-purifying respirator (PAPR) equipped with combination high-efficiency particulate air (HEPA) or P-100 filter and organic vapor/acid gas cartridges/canister. If only splatter of body fluids is anticipated, surgical masks may be used with eye protection or face shields.
Surgery on Living Infectious Patients	• As general precaution, Standard, Contact, and Airborne Precautions should be used. A NIOSH-Certified loose-fitting helmet/hooded PAPR with a surgical mask is preferred, but if this is not possible, use a half-facepiece respirator (equipped with P-100 filter) without an exhalation valve in conjunction with a face shield or goggles. If only splatter of body fluids is anticipated, and no aerosols, surgical masks may be used with eye protection or face shields.
<i>CWA, TICs, Radiological and Nuclear</i>	Standard Precautions

Note: The assumptions made in this table are that victims will have been adequately decontaminated before entering the MTF.

Table 5-B: Personnel Performing Decontamination or Life-Saving Procedures on Contaminated Victims at the MTF - Exposures to *TICs* or *CWAs*

PPE	Advantages	Disadvantages
Level B (with NIOSH-Certified tight-fitting full-facepiece atmosphere supplying respirator as either SCBA or airline (with escape-only SCBA, if indoors); hood; boot covers and rubber boots or one-piece chemical protective overboot; chemical protective clothing and gloves (e.g., butyl rubber glove worn over an inner disposable nitrile glove; if advanced medical care (e.g., endotracheal intubation, etc.) is necessary before decon, use 7-mil or 14-mil butyl rubber glove w/o nitrile glove; if sterility is required, double glove with disposable nitrile gloves, changing every ½ hour (after physically contacting a contaminated person and between touching patients); consult para. 5.4.3.B, pages 63-64).	Complies with OSHA when chemicals present an actual or potential inhalation hazard and the air contaminants have not been identified or the air concentrations have not been estimated to justify a lowering to Level C PPE. Provides the highest level of respiratory protection.	Some medical personnel are concerned that if life-saving procedures need be done before victims are decontaminated, it may be difficult for medical personnel to deliver these procedures in Level B. Airline hoses may pose tripping hazards and may decrease mobility. SCBA air tanks may be heavy and bulky. Air-supply tanks will have to be changed every 30-45 minutes. Respirator requires fit-testing prior to use.
Level C [with NIOSH-Certified tight-fitting full-facepiece PAPR equipped with combination HEPA or P-100 filter and organic and acid gas cartridges/canister; chemical protective clothing; gloves, as above; hood covers; boot covers and rubber boots or one-piece chemical protective overboot]	Provides a very high level of respiratory protection, greater than a non-powered APR and possibly as high as an airline respirator in some circumstances. Even if the battery dies, contaminated air is still filtered and the respirator therefore still provides some protection until a new battery can be installed. Easier to breathe with than a non-powered APR.	Does not comply with OSHA when chemicals present an actual or potential inhalation hazard and the air contaminants have not been identified or the air concentrations have not been estimated to justify a lowering to Level C PPE. Respirator requires fit-testing prior to use.
Level C [with NIOSH-Certified loose-fitting helmet/hooded PAPRs equipped with combination HEPA or P-100 filter and organic and acid gas cartridges/canister. The manufacturer should supply data demonstrating an APF equivalent to a tight-fitting PAPR; chemical protective clothing; gloves, as above; boot covers and rubber boots or one-piece chemical protective overboot]	Same as with tight-fitting full-facepiece PAPR, in addition to the following. The respirator does not require fit-testing prior to use. May be more comfortable than a tight-fitting full-facepiece PAPR or non-powered APR.	Unlike a tight-fitting PAPR, if the battery fails, the respirator provides no protection and the user will breathe unfiltered contaminated air. To prevent this from happening, a rigorous program must be established to ensure that batteries are well maintained and will provide sustained performance during the response. Batteries should include those that are rechargeable (e.g., NiCd) and non-rechargeable with extended shelf life (e.g., Lithium)
Level C [with NIOSH-Certified full-facepiece non-powered APR equipped with combination P-100 filter and organic and acid gas cartridges; chemical protective clothing; gloves, as above; boot covers and rubber boots or one-piece chemical protective overboot.]	Not as expensive as the respirators indicated above.	Provides less respiratory protection than the respirators indicated above. Respirator requires fit-testing prior to use.

Note 1: The respirators, chemical protective clothing and gloves must be demonstrated to be effective against CWA and TICs.

Note 2: A minimum of a PAPR is highly recommended for respiratory protection and it is likely that PAPRs may prove to be the best overall procurement choice, however, any of the indicated respirators may be used.

Table 5-C: Personnel Performing Decontamination or Life-Saving Procedures on Contaminated Victims at the MTF - Exposures to *BWAs* (after an overt attack) or *Nuclear/Radiological Materials*

PPE	Advantages	Disadvantages
The PPE recommended in Table 5-B for TICs and CWA can also be used for protection against BWA and nuclear/radiological materials.	Procuring and using the same PPE for all terrorist agents simplifies things, and ensures the proper PPE is always used. It may be impractical and perhaps result in confusion to have one set of PPE available for TICs/CWA and another for BWAs/radiological/nuclear materials.	If only BWA or nuclear/radiological materials are involved, using PPE that is also effective against TICs and CWA may be unnecessarily protective and costly.
Level C [with NIOSH-Certified tight-fitting full-facepiece PAPR equipped with HEPA or P-100 filter; rubber gloves; Tyvek or equivalent garments; head and boot covers, etc.]	Provides a very high level of respiratory protection, possibly as high as an airline respirator in some circumstances and greater than a non-powered APR. Even if the battery dies, contaminated air is still filtered and the respirator therefore still provides some protection until a new battery can be installed. Easier to breathe with than a non-powered APR.	Respirator requires fit-testing prior to use.
Level C [with NIOSH-Certified loose-fitting helmet/hooded PAPRs equipped with HEPA or P-100 filter (the manufacturer should supply data demonstrating an APF equivalent to a tight-fitting PAPR); rubber gloves; Tyvek or equivalent garments; boot covers, etc.]	Same as with tight-fitting full-facepiece PAPR, with the addition of the following. The respirator does not require fit-testing prior to use. May be more comfortable than a tight-fitting full-facepiece PAPR or non-powered APR.	Unlike a tight-fitting PAPR, if the battery fails, the respirator provides no protection and the user will breathe unfiltered contaminated air. To prevent this from happening, a rigorous program must be established to ensure that batteries are well maintained and will provide sustained performance during the response. Batteries should include those that are rechargeable (e.g., NiCad) and non-rechargeable with extended shelf life (e.g., Lithium)
Level C [with NIOSH-Certified full-facepiece non-powered APR equipped with P-100 filter; rubber gloves; Tyvek or equivalent garments; hood and boot covers.]	Not as expensive as the respirators indicated above.	Provides less respiratory protection than the respirators indicated above. Respirator requires fit-testing prior to use.

Note 1: A minimum of a PAPR is preferred for respiratory protection and it is likely that PAPRs may prove to be the best overall procurement choice, however, a full-facepiece non-powered APR is acceptable.

Note 2: For T-2 mycotoxins, use the PPE as described in Table 5-B for CWAs and TICs.

Table 5-D: Triage and Perimeter Security Personnel at the MTF - Exposures to TICs and CWAs

Triage Category, Terrorist Agent, and PPE	Advantages	Disadvantages
<i>Primary Triage and Perimeter Security</i>		
Level C with a PAPR (as described in Table 5-B) is preferred, if possible.	See Table 5-B	See Table 5-B
Level C [with NIOSH-Certified full-facepiece non-powered APR equipped with combination P-100 filter and organic and acid gas cartridges; chemical protective clothing and gloves (e.g., consult para. 5.4.3.B., pages 63-64); boot covers and rubber boots or one-piece chemical protective overboot.]	Not as expensive as a PAPR and is likely to offer enough protection in most situations.	Provides less respiratory protection than a PAPR. May not be as comfortable to wear as a PAPR. Respirator requires fit-testing prior to use.
<i>Secondary Triage – TICs and CWAs</i>		
Use of Level C PPE as recommended for Primary Triage personnel is discretionary for Secondary Triage personnel, unless circumstances and monitoring dictate otherwise. Except for the Standard Precaution PPE, no other special PPE is likely necessary, but may depend on the situation. The assumption made herein is that patients have been adequately decontaminated and pose no significant health hazard to secondary triage personnel, they are upwind from the decontamination area, and contaminated clothing is removed and contained upwind.		

Note 1: the respirators, CPC, and gloves must be demonstrated to be effective against CWA and TICs.

Note 2: It may be prudent to procure Level C PPE for secondary triage personnel, to be accessible should circumstance and monitoring indicate it is necessary.

Table 5-E: Triage and Perimeter Security Personnel at the MTF - Exposures to BWAs (after an overt attack) and Radiological/Nuclear Materials

Triage Category, Terrorist Agent, and PPE	Advantages	Disadvantages
<i>Primary Triage and Perimeter Security</i>		
The PPE recommended in Table 5-D for TICs and CWA can also be used for protection against BWA and nuclear/radiological materials.	Procuring and using the same PPE for all terrorist agents simplifies things, and ensures the proper PPE is always used. It may be impractical and perhaps result in confusion to have one set of PPE available for TICs/CWA and another for BWAs/radiological/nuclear materials.	If only BWA or nuclear/radiological materials are involved, using PPE that is also effective against TICs and CWA may be unnecessarily protective and costly.
Level C with a PAPR (as described in Table 5-C) is preferred, if possible, however, a non-powered APR as described below is acceptable. However, if procuring Level C with a PAPR, it may be wiser to procure one with the filters and cartridges as described for PAPRs in Table 5-B, since it would also protect against TICs and CWAs.	See Table 5-B and Table 5-C	See Table 5-B and Table 5-C
Level C [with NIOSH-Certified full-facepiece non-powered APR equipped with P-100 filter; Tyvek or equivalent garments; hood and boot covers; rubber gloves.]	Not as expensive as a PAPR and is likely to provide sufficient protection in most situations.	Provides less respiratory protection than a PAPR. Respirator requires fit-testing prior to use.
<i>Secondary Triage</i>		
Use of Level C PPE as recommended for Primary Triage personnel is discretionary for Secondary Triage personnel, unless circumstances and monitoring dictate otherwise. Except for the Standard Precaution PPE, no other special PPE is likely necessary, but may depend on the situation. The assumption made herein is that patients have been adequately decontaminated and pose no significant health hazard to secondary triage personnel, they are upwind from the decontamination area, and contaminated clothing is removed and contained upwind.		

Note 1: It may be prudent to procure Level C PPE for secondary triage personnel, to be accessible should circumstance and monitoring indicate it is necessary.

Note 2: For T-2 mycotoxins, use the PPE as described in Table 5-D for CWAs and TICs.

Table 5-F: Personnel Transporting (e.g., in ambulance) Victims to the MTF - Exposures to TICs or CWAs

PPE	Advantages	Disadvantages
<i>Patients grossly and secondarily decontaminated or not requiring decontamination.</i>		
Standard Precaution PPE.		
<i>Contaminated patients that have undergone gross but not secondary decontamination.</i>		
Level C with a PAPR (as described in Table 5-B) is preferred, if possible.	See Table 5-B	See Table 5-B
Level C [with NIOSH-Certified full-facepiece non-powered APR equipped with combination P-100 filter and organic and acid gas cartridges; chemical protective clothing and gloves (e.g., butyl rubber glove over an inner disposable nitrile glove); hood; boot covers and rubber boots or one-piece chemical protective overboot.]	Not as expensive as a PAPR and is likely to offer enough protection in most situations.	Provides less respiratory protection than a PAPR. May not be as comfortable to wear as a PAPR. Respirator requires fit-testing prior to use.

Note 1: The respirators, chemical protective clothing and gloves must be demonstrated to be effective against CWA and TICs.

Note 2: Ensure there is good fresh air ventilation inside the ambulance to minimize the vapor concentration.

Note 3: It is highly recommended that victims contaminated with CWA be thoroughly decontaminated (gross and secondary decontamination) before they are allowed to enter the ambulance, for the protection of both the ambulance crew and the contaminated victim.

Note 4: Victims contaminated with TICs should have undergone gross decontamination, at a minimum, before they are allowed to enter the ambulance.

Table 5-G: Personnel Transporting (e.g., in ambulance) Victims to the MTF - Exposures to BWA (after an overt attack) and Radiological/Nuclear Materials

PPE	Advantages	Disadvantages
<i>Patients grossly and secondarily decontaminated or not requiring decontamination:</i>		
Standard Precaution PPE.		
<i>Contaminated patients that have undergone gross but not secondary decontamination.</i>		
The PPE recommended in Table 5-F for TICs and CWA can also be used for protection against nuclear/radiological materials.	Procuring and using the same PPE for all terrorist agents simplifies things, and ensures the proper PPE is always used. It may be impractical and perhaps result in confusion to have one set of PPE available for TICs/CWA and another for BWAs/radiological/nuclear materials.	If only BWA or nuclear/radiological materials are involved, using PPE that is also effective against TICs and CWA may be unnecessarily protective and costly.
Level C with a PAPR (as described in Table 5-G) is preferred, however, a non-powered APR as indicated below is acceptable. However, if procuring Level C with a PAPR, it may be wiser to procure one with the filters and cartridges as described for PAPRs in Table 5-B), since it would also protect against TICs and CWAs.	See Table 5-B and Table 5-C	See Table 5-B and Table 5-C
Level C [with NIOSH-Certified full-facepiece non-powered APR equipped with P-100 filter; Tyvek or equivalent garments; hood and boot covers; rubber gloves.]	Not as expensive as a PAPR and is likely to provide sufficient protection in most situations.	Provides less respiratory protection than a PAPR. Respirator requires fit-testing prior to use.

Note: For T-2 mycotoxins, use PPE as described in Table 5-F.

Table 5-H. Incident Site – Hot Zone (or Exclusion Area)

CWA	TIC	BWA	Radiological /Nuclear
Level A (initially) with NIOSH-Certified SCBA. The PPE level may be lowered if air monitoring indicates this is safe to do.	Level A or B (initially) with a NIOSH-Certified SCBA, the level depending on the chemical or situation. The PPE level may be lowered if air monitoring indicates this is safe to do.	Level A or Level B (with NIOSH-Certified SCBA), or Level C (with NIOSH-Certified PAPR, equipped with HEPA filters) or Level C (with NIOSH-Certified full-facepiece APR, equipped with P-100 filter), depending on situation. See Appendices E and F for scenarios and corresponding recommended PPE levels.	<i>Short-duration exposure:</i> Level C with a NIOSH-Certified full-facepiece non-powered APR equipped with combination P-100 filter and organic vapor and acid gas cartridges/canister is acceptable, but a PAPR equipped with combination HEPA or P-100 filter and organic vapor and acid gas cartridges/canister is preferred; gloves; Tyvek or equivalent garments; hood and boot covers. <i>Extended-duration exposure (days, weeks, months):</i> Level B or Level C with a PAPR equipped with HEPA or P-100 filter and organic vapor and acid gas cartridges/canister, depending; gloves; Tyvek or equivalent garments; hood and boot covers.

Note: When responding to fires or entering buildings on fire, structural firefighting gear should be worn – including helmet, SCBA, and turnout gear (thermally insulated coat, pants, and boots.)

Table 5-I. Incident Site – Decontamination Zone (or Warm Zone) and Support Zone (or Cold Zone)

CWA	TIC	BWA	Radiological /Nuclear
<i>Decontamination Zone (or Warm Zone)</i>	<i>Decontamination Zone (or Warm Zone)</i>	<i>Decontamination Zone (or Warm Zone)</i>	<i>Decontamination Zone (or Warm Zone)</i>
Same PPE level as that used in the Hot Zone or one PPE Level lower than that used in the Hot Zone if professional judgment or air monitoring indicates this is safe to do.	Same PPE level as that used in the Hot Zone or one PPE Level lower than that used in the Hot Zone if professional judgment or air monitoring indicates this is safe to do.	One PPE Level lower than that used in the Hot Zone.	Same PPE level as used during short-duration exposure in the Hot Zone
<i>Support Zone (or Cold Zone)</i>	<i>Support Zone (or Cold Zone)</i>	<i>Support Zone (or Cold Zone)</i>	<i>Support Zone (or Cold Zone)</i>
Standard Precaution PPE	Standard Precaution PPE	Standard Precaution PPE	Standard Precaution PPE

5.2. How to Use This Section.

5.2.1. Readers should first read Section I to familiarize themselves with potential terrorist agents. Users should then read this Chapter (including PPE Quick Selection Summary Tables 5-A through 5-I) before proceeding to specific Chapters in this Section, Section II, for BWA terrorism, CWA terrorism, TIC Terrorism, and Nuclear and Radiological Terrorism. Also, it is absolutely essential that users read Section III to ensure that PPE program requirements are being met (*e.g., medical approval granted for respirator users before they are permitted to wear a respirator, fit-testing of respirators to make sure they fit properly, training on respirators and other PPE, etc.*) otherwise the benefits of even properly selected PPE can be jeopardized or greatly diminished.

5.2.2. Chapters 6-9 in this Section are each subdivided into two subparagraphs, “PPE Guidelines for Handling Patients Arriving at the MTF” and “PPE Guidelines for Handling Patients Before Arriving at the MTF.”

A. Chapters 6-9, subparagraphs titled: “PPE Guidelines for Handling Patients Arriving at the MTF”.

(1) *Content and flow.* In chapters 6-9, this subparagraph will consider PPE recommended for care of patients inside the MTF and PPE recommended for personnel directly outside the MTF, i.e., those personnel, such as security personnel, triage personnel, and decontamination personnel who may encounter contaminated victims as they arrive at the MTF. The flow of this paragraph will begin inside the MTF and is followed by PPE guidance for personnel outside the MTF.

(2) *General statement about the PPE recommendations for those at the MTF.*

(A) The MTF staff’s PPE must be sufficient for the type and exposure levels an employee can reasonably anticipate from an incident. Emergency response planning includes the selection of PPE based on reasonable worst-case exposure scenarios. PPE selection should be based on the MTF’s role in emergency responses.

(B) A hazard assessment is required to select appropriate PPE for the hazards that are present, or likely to be present, including foreseeable emergencies. The hazard assessment for PPE (other than respiratory protection) must be in the form of a written certification (Ref. 12a). Respiratory hazard evaluations must include a reasonable estimate of employee exposures and an identification of the contaminant’s chemical state and physical form (Ref. 12c) – the exposure estimate does not have to be made by taking actual measurements (Ref. 158), but may come from exposure data reported from similar events, mathematical models, etc.

(C) General recommendations for respiratory protection and PPE are recommended herein, and it is believed the recommendations will be adequate for most situations. However, the type of respiratory protection and PPE needed at an MTF may differ depending upon the threat analysis, hazard assessment, and exposure estimates conducted for the specific MTF site. For instance, a threat analysis might indicate a reasonably high probability of

exposure to a certain TIC that may require different APR cartridges or gloves than the ones recommended herein. Also, CBRN and TIC hazard assessment and exposure estimates - conducted for the specific MTF site - might indicate that the level of PPE needs to be upgraded or may be permitted to be downgraded. Therefore, it should be understood that MTF Safety and Health professionals should ultimately decide the level and type of PPE to be worn, based upon their professional judgment.

(3) PPE for healthcare personnel inside the MTF.

(A) Patients who have been thoroughly and effectively decontaminated are safe for care in normal hospital attire and procedures (i.e., Standard Precautions, infection control precautions). Special PPE is sometimes necessary when handling patients that have certain diseases caused by BWAs, and such recommendations are made in Chapter 6, as necessary. Otherwise, no special PPE is recommended for those inside the MTF, except that required for Standard Precautions, since the assumption made in this technical guide is that personnel admitted inside the MTF have been adequately decontaminated and pose no significant health hazard to healthcare personnel interacting with them.

(4) PPE for triage personnel.

(A) Triage officer training and experience. The triage officer should ideally be a trained emergency physician who is very familiar with handling and treating casualties of weapons of mass destruction (Ref 71). Alternatives would be another trained and experienced acute care physician, physician assistant, nurse practitioner, emergency registered nurse or paramedic (Ref. 71).

(B) Triage procedures. General guidance is provided below. However, this is not a “how to” triage guide and no intent is made to advocate one method of triage over another. Other references should be consulted for further information (e.g., Ref. 40, Ref. 48, Ref. 49, Ref. 52, Ref. 55, Ref. 69, and Ref. 71).

(C) Primary triage personnel.

- Patients are received at the MTF by ambulance, private vehicles, and walk-ins. Those in primary triage briefly assess patients. Depending on triage methods/guidelines used, the primary triage personnel and the follow-on decon personnel designated to provide medical evaluation and treatment during the decon have specific roles regarding taking necessary vital signs and providing immediate life-saving care. The primary triage personnel may use specific brief vital signs (e.g., respirations, pulse) in determining priorities for decon and may need to provide immediate life-saving actions (such as opening the airway, stopping life-threatening bleeding) during their quick evaluation before decon. Another method described by Barbera et. al. (2001) recommends that the primary triage personnel do not do vital signs, provide care, etc. but direct potentially contaminated patients to either the ambulatory (non-medical) or non-ambulatory (medical) decontamination stations (Ref. 71). Under this method, those requiring immediate life-saving actions would get them in the non-ambulatory decon station even before actually going through decon if needed, especially if there is a delay in

beginning decon. Clearly this requires very quick transfer of patients from the triage station to the medical personnel who will provide these lifesaving actions in the non-ambulatory decon station. Barbera et. al. (2001) define ambulatory and non-ambulatory casualties as follows (Ref. 71):

- *Ambulatory Casualties:* Victims who are able to understand and follow DECON directions, can talk and are self-sufficient with locomotion (or accompanied by someone who will provide adequate assistance with movement through the DECON stations). They will generally require no or minimal medical intervention prior to completion of decontamination.

- *Non-ambulatory Casualties:* Victims with mental status changes, unable to comprehend or follow DECON instructions, or who may require significant medical intervention (airway control, medication injection, and others) prior to completion of decontamination.

- A minimum of Level C PPE is recommended herein. For BWA (after an overt attack) and nuclear and radiological materials, this would include rubber gloves, Tyvek or equivalent garments, head and boot covers, and a minimum of a full-facepiece APR equipped with a Class 100 filter - Level C with a PAPR (as described in Table 5-E) is preferred, if possible. For CWAs and TICs, this would include gloves (i.e., consult para. 5.4.3.B, pages 63-64), chemical protective clothing, and a minimum of a full-facepiece APR equipped with combination P-100 filter, and organic vapor and acid gas cartridges – Level C with a PAPR (as described in Table 5-D) is preferred, if possible.

(D) Secondary triage personnel. Once patients leave the decontamination stations, they are considered clean, and they proceed to secondary triage. Secondary triage is the first opportunity for a hospital care-provider to evaluate patients without a PPE barrier and more information is gathered than during primary triage (Ref. 71). Triage categories can vary depending on methods/guidelines used and the degree to which medical and other resources are being stressed. In situations where resources are clearly overwhelmed, prioritization may be based on the most good for the most people and a scheme such as immediate, delayed, minimal and expectant has been used (this might even be considered in primary triage). Another method recommends that patients are categorized into four injury/illness groups (Major, Moderate, Minor, and No Apparent Injury), and sent to various treatment areas, accordingly (Ref. 71). There should be a dependable communication system between primary triage, decontamination, secondary triage, and the ER treatment area inside the MTF (Ref. 71).

- Except for the Standard Precaution PPE, no other special PPE is likely necessary for those performing secondary triage. The assumption made herein is that patients have been adequately decontaminated and pose no significant health hazard to secondary triage personnel, they are upwind from the decontamination area, and contaminated clothing is removed and contained upwind. Therefore, use of Level C PPE as recommended for Primary Triage personnel is discretionary for secondary personnel, unless circumstances and monitoring dictate otherwise. It may be prudent to procure Level C PPE for secondary triage personnel, to be accessible should circumstance and monitoring indicate it is necessary.

(5) *Decontamination of patients arriving at the MTF.*

(A) Patients arriving by ambulance. Ideally, patients arriving by ambulance should have already been grossly and secondarily decontaminated, when warranted, before entering the ambulance. However, it is possible that these contaminated patients had been grossly but incompletely decontaminated before entering the ambulance. If this is the case, both the transported contaminated patient and possibly contaminated emergency medical service personnel require decontamination before being allowed to enter the facility. Any vehicle used to transport contaminated patients must be isolated until appropriate decontamination has been carried out.

(B) Patients self-presenting to the MTF. Some victims may self-present to the MTF. These patients may or may not require decontamination. If there is any uncertainty, decontaminate.

(6) *PPE for decontamination personnel: protection against BWA (after an overt attack) and radioactive materials.* Minimum of Level C PPE is recommended, which includes a full-facepiece air-purifying respirator equipped with a P-100 or high-efficiency particulate air (HEPA) filter, rubber gloves, Tyvek or equivalent garments, hood and boot covers. However, a PAPR (as described in Table 5-C) is preferred for respiratory protection, if possible. Note: for T-2 mycotoxins, use the PPE as described in Table 5-B for CWAs and TICs.

(7) *PPE for decontamination personnel: protection against CWAs and TICs.* Those in primary triage direct potentially contaminated patients to either the ambulatory (non-medical) or non-ambulatory (medical) decontamination stations (Ref. 71). If necessary, life saving procedures would be performed in the non-ambulatory (medical) decontamination station (Ref. 71). Those performing decontamination or assisting in the decontamination would have to wear PPE. Once the patients leave the decontamination stations, they are considered clean, and they proceed to secondary triage.

(A) Based upon the discussion below, though Level B may be ideal (in terms of offering the highest level of respiratory protection for the user, etc.), it is possible that it may not be practical, and it is expected that Level C may be sufficiently protective against most (but perhaps not all) scenarios. Level C with a non-powered full-facepiece APR is the least attractive of the choices provided in Table 5-B, since it provides the least protection of the choices provided. In consideration of the various factors discussed herein, a minimum of a PAPR (as described in Table 5-B) is highly recommended for respiratory protection and it is likely that a PAPR may prove to be the best overall procurement choice, offering practicality and a high degree of protection against most materials. However, any of the indicated respirators in Table 5-B may be used.

(B) For those performing decontamination or life-saving care of patients before/during decontamination, Level B (includes atmosphere supplying respirator as either SCBA or airline) PPE is ideal unless the types of air contaminants have been identified, exposure concentrations estimated, an APR is available that can remove the contaminants, and all criteria

for the use of APRs are met. However, if life-saving procedures need to be done before victims are decontaminated, it may be difficult for medical personnel to deliver these procedures in Level B.

(C) Direct-reading air-monitoring detectors could be used to validate a lower level of PPE (e.g., Level C, includes NIOSH-Certified air-purifying respirator, etc.), but, it is not expected that most MTFs will have these detectors. If the decontamination team at the incident site is using a lower level (e.g., Level C) of protection because they have identified the contaminant and its concentration and deemed a lower level to provide adequate protection, this could justify the use of Level C PPE. Historical exposure data (if available) from similar events could also be used (in advance of any terrorist incident) to justify the use of Level C PPE. Threat analysis and mathematical modeling could also be done (in advance of any terrorist incident) to estimate the type of contaminants and reasonable worst-case exposures.

(D) Level C [with NIOSH-Certified tight-fitting full-face Powered Air-Purifying Respirator (PAPR) equipped with combination HEPA or P-100 filter and organic and acid gas cartridges/canister] may be adequate for most situations but may not be compliant with OSHA unless the types of air contaminants have been identified and exposure estimates made to prove a lower level of respiratory protection is acceptable. It is further indicated in this guide that Level C with loose-fitting helmet/hooded PAPRs should only be used if there is a rigorous program ensuring that batteries are well maintained (and will provide sustained performance during the response) and the manufacturer supplies data that demonstrates an Assigned Protection Factor (APF) equivalent to a tight-fitting PAPR.

(E) A NIOSH-Certified non-powered full-facepiece APR equipped with combination P100 filter and organic and acid gas cartridges may also be sufficient, but is less desirable than a tight-fitting PAPR. Others have recommended Level C PPE for decontamination personnel. For example, Barbera et. al. (2001) recommended Level C PPE with a respirator equipped with combination HEPA or P-100-filter/organic vapor cartridges unless clinical symptoms or information from the scene dictates otherwise or when the hospital is within the incident location or when a known or suspected agent requires a higher level of PPE (Ref. 71).

(F) To be compliant with OSHA, Level B is one of the recommendations made, herein, because no data appears to be available that would allow one to state unequivocally that Level C APRs would work for all TICs and CWA exposures. However, on an intuitive level, a full-facepiece APR (particularly if a PAPR) equipped with the proper cartridges/canister is likely to be sufficient in many cases, but perhaps not all (e.g., some cartridges/canisters may not remove/filter certain chemicals). The following questions naturally follow.

- Is it possible for the exposure to some chemicals to exceed Immediately Dangerous to Life and Health (IDLH) concentrations, which would require Level B? Intuitively, one would not think so.
- Is it possible that exposures might exceed the maximum use concentration (MUC) of an APR, which is a function of the type of facepiece (e.g., half or full-facepiece) worn

and the adsorption capacity of the cartridge or canister? This may be a possibility in some situations – and would be more likely with a non-powered APR than a PAPR – therefore, it is possible that Level B may be necessary in some instances, but there was no data available at the time of writing this technical guide that would answer this question unequivocally.

- Is it possible that there may be incidents with TICs where the available cartridges or canisters on an APR would not filter/remove any of the contaminant, so the APR would provide no protection whatsoever? This is a possibility and if exposures could conceivably exceed the exposure limit for the particular TIC, an atmosphere-supplying respirator may be necessary (with consideration of the physiologic and toxicological consequences if exceeding the exposure limit).

(G) An inter-agency working group [*U.S. Army Soldier and Biological Chemical Command (SBCCOM), Veterans Health Administration (VHA), Environmental & Occupational Health Sciences Institute*] is evaluating whether Level C (as opposed to Level B) can be justified to be worn by those at the hospital receiving victims of a CWA attack. Detailed mathematical modeling is being done for receiving victims of a sarin attack. A report of their findings is expected to be published in 2003.

(8) General Principles Regarding Decontamination at the MTF.

(A) Location Issues.

- The best place to set up a decontamination area is outside the main facility (Ref. 73). Prearrange for tents or other temporary structures (Ref. 73) that ensure privacy and shelter. Outdoor decontamination is preferable for several reasons. First, it protects the facility's staff, equipment, and other patients from becoming contaminated (Ref. 73). Second, outdoor ventilation will help keep airborne cross-exposure low. Third, if a large volume of victims enter the main facility, it can be very difficult to keep the contamination contained and away from other care settings (Ref. 73). The possibility that the contamination may spread is real and must be considered (Ref. 73). The emergency management plan should address how the organization would respond to the functional loss of part of the facility due to contamination to ensure the continued quality and safety of patient care and protection of staff (Ref. 73).

- Some MTFs have a dedicated decontamination room. This is acceptable, as long as there are only a few contaminated victims to treat and they do not have to be transported a long distance through the emergency department or other common areas (Ref. 73). This room should have easy access and should not be in close proximity to other care areas (Ref. 73). The outside access door should have restricted entry. The decontamination room must be under negative pressure with respect to adjacent rooms of less contamination potential, room air must be exhausted outside, and there must be floor drains to contain potentially contaminated liquid runoff.

- It is important to coordinate decontamination efforts with local community's HAZMAT response team (Ref. 73). This team may have portable decontamination units and prefer to go directly to the site of the contamination rather than risk spreading the

contaminant to other sites, including your facility, by moving contaminated individuals (Ref. 73). Realize, though, that in a large event, many (up to 80%) contaminated individuals will probably arrive at your facility before the HAZMAT team can assess and control the situation, especially if individuals come via personal vehicle rather than through the local emergency medical service (EMS).

- Also, evaluate your facility's air-handling systems (Ref. 73). In a terrorist event, some victims may arrive at the health care facility before the details or implications of the event are clearly understood (Ref. 73). Determine how you would isolate your HVAC systems to prevent spreading a contaminant throughout the building (Ref. 73).

(B) Applicability. It should be noted that the Joint Commission on Healthcare Organizations (JCAHO) does not require (per EC.1.4, Emergency Response Plan standard for hospitals) MTFs to have the ability to decontaminate patients (Ref. 83). However, an MTF that does not have the ability to decontaminate patients must identify other locations/facilities where patients will be decontaminated (Ref. 83) and should also develop procedures on what to do if contaminated patients still happen to show up at their own facility.

(C) General decontamination principles and procedures.

- This technical guide is not a decontamination guide but some important decontamination principles are included here. Other guidance should be consulted to develop specific procedures.

If a victim has been contaminated with a liquid chemical (CWA or TIC) or solid particulate (biological or radiological), a significant amount of the contamination can be removed by grossly decontaminating the victim. That is, by removal of the victim's contaminated clothing and following with a 1-minute-long rinsing from head to toe with tepid water (slightly warm, not hot!).

Macintyre et. al. (2000) cite some authors as suggesting that as much as 75% to 90% of the hazardous agent may be removed simply by disrobing (Ref. 72). However, for TIC or CWA contamination, NIST (2002) indicate that this depends upon what the person is wearing (e.g., a long or short-sleeved shirt, long or short pants, socks and shoes, undershirt, and underwear) and calculate this may range from 50% (with short-sleeved blouse, skirt, socks, and shoes) to as high as 80% (with long-sleeved shirt, long pants, socks, and shoes) (Ref. 137). One would also think that this would also depend upon how much of the liquid had penetrated through the clothing to the skin before removing it. Regarding particulate contamination, according to Army FM 8-284, removal of a soldier's battle dress overgarment (BDO) normally removes about 90% to 94% of BWA (Ref. 49). AFRRI (1999) indicates that removal of outer clothing and rapid washing of exposed skin and hair removes 95% of radiological contamination on a person (Ref. 85). However, as with TICs and CWA, the amount of BWA or radiological contamination removed (by removing contaminated clothing) would also likely depend on the type and amount of clothing worn, so contamination

removal may be less in some circumstances (e.g., if short-sleeves or short-pants or skirt is worn).

The 1-minute-long water rinse (from head to toe) during gross decontamination (of TICs, CWA, BWA, or radiological) would remove even further contamination. Note: if the victim is contaminated with a pure metal solid or a strong corrosive solid, dry decontamination (i.e., gentle brushing or vacuuming of larger particles) is required before water is applied (Ref. 72).

Victims with liquid CWA or TIC contamination should be decontaminated as rapidly as possible since some chemicals can be absorbed systemically through the skin, whereas others may damage (e.g., burn) the skin. Victims contaminated with T-2 mycotoxin should also be decontaminated as soon as possible, because of its dermal toxicity (may result in blisters severe skin and eye irritation). For instance, though a delayed soap and water washing within 4-6 hours after exposure to T-2 mycotoxin can still significantly reduce dermal toxicity, if decontaminated within 1 hour after dermal exposure, dermal toxicity may be prevented, entirely (Ref. 48).

A more thorough and deliberate decontamination should follow the gross decontamination of victims with liquid chemical (TIC or CWA) or particulate (BWA or radiological) contamination, making the patient as clean as possible. Secondary or definitive decontamination usually includes washing with a mild soap (e.g., dishwashing detergent), tepid water (slightly warm, not hot!), and soft sponges (no stiff brushes, abrasives, or vigorous scrubbing!) in an organized and thorough manner (Ref. 69, Ref. 72). Note: if the victim is contaminated with a pure metal solid or a strong corrosive solid, dry decontamination (i.e., gentle brushing or vacuuming of larger particles) is required before water is applied (Ref. 72).

- Other references should be consulted for a more thorough discussion of decontamination procedures (e.g., Ref. 48, Ref. 51, Ref. 52, Ref. 55, Ref. 69, Ref. 71, Ref. 72, Ref. 118, Ref. 122, Ref. 132, and Ref. 137).

(D) Macintyre et. al. (2000) indicate that the use of detectors (to verify that decontamination is adequate) at the healthcare facility environment is controversial and that further research is required, but believe they would only complicate and lengthen the decontamination process and therefore advise against their use (Ref. 72). With the exception of radiation detectors, Barbera et. al. (2001) advise against their use in the healthcare facility environment (Ref. 71). The ATSDR (2001) also indicate that detector monitors would have limited value to determine the adequacy of decontamination (Ref. 69).

- The effectiveness of decontaminating victims of liquid chemical contamination can be done with a combination of methods, such as air monitoring and wipe testing. For instance, swipe sampling, cloth or paper patches may be wiped over a decontaminated surface or skin, and color changes may be noted which could indicate the

possible presence of remaining residual liquid chemical contamination. The presence of beta and gamma radiological contamination can be readily confirmed by passing a radiation detector (radiac) over the entire body (Ref. 55, Ref. 116) – see Chapter 4. Air monitoring can detect chemical vapors emanating from any residual liquid contamination remaining on the victim. *Still, some monitoring equipment and methods may not be readily available, operation of some equipment and materials may require skilled operators, in some cases the results may be inconclusive or of limited value, and in some instances, may also possibly complicate and lengthen the decontamination process. However, there are exceptions to this, such as with the use of a radiation detector (radiac), which should be used to detect beta and gamma radiological contamination. In most cases, however, the adequacy of decontamination may have to be based exclusively on best clinical judgment and visual observation and by following an effective and established decontamination procedure.*

- Other references should be consulted for a more thorough discussion of air and surface contamination monitoring (e.g., Ref. 48, Ref. 49, Ref. 51, Ref. 52, Ref. 53, Ref. 55, Ref. 88, Ref. 92, Ref. 116, Ref. 117, Ref. 118, Ref. 119, Ref. 121, Ref. 122, Ref. 123, Ref. 125, Ref. 130, and Ref. 141).

(9) *PPE for Perimeter Security (e.g., Security Officers).*

(A) Training. Perimeter security must be trained to recognize potentially contaminated victims from their appearance, complaints or symptoms (Ref. 71).

(B) Function. Perimeter personnel stop victims from entering the MTF, and redirect them toward the decontamination area, notify MTF decontamination personnel that a victim has been directed to the decontamination area, notify emergency department personnel, and control all MTF entrances (all unmanned entrances locked with signs directing people to controlled entrances) (Ref. 71).

(C) PPE. A minimum of Level C PPE is recommended herein. For BWA (after an overt attack) and nuclear and radiological materials, this would include rubber gloves, Tyvek or equivalent garments, hood and boot covers, and a minimum of a full-facepiece APR equipped with a Class 100 filter - Level C with a PAPR (as described in Table 5-E) is preferred, if possible. For T-2 mycotoxins, use the same PPE as recommended for CWAs and TICs. For CWA and TICs, this would include gloves (butyl rubber glove worn over an inner disposable nitrile glove), chemical protective clothing, hood, boot covers and rubber boots or one-piece chemical protective overboot, and a minimum of a full-facepiece APR equipped with combination Class 100 filter and organic vapor and acid gas cartridges - Level C with a PAPR (as described in Table 5-D) is preferred, if possible. The assumption made herein is that security personnel would have less interaction and exposure potential than those performing decontamination and life-saving procedures in the decontamination stations. That is, perimeter security personnel would only be directing victims to go to certain areas and would be expected to have minimal close or physical contact. Further, it is not expected that perimeter security personnel could do their jobs in a higher PPE Level (e.g., Level B) because it would be impractical from a mobility standpoint.

B. Chapters 6-9, subparagraphs titled: “PPE Guidelines for Handling Patients Before Arriving at the MTF”.

(1) *Applicability.* This chapter subparagraph (in Chapters 6-9) will not be applicable for MTFs that do not have personnel that either go to the incident site or transport victims in an ambulance from the incident site to their MTF for treatment. Some MTFs may have some personnel that go to the incident site to retrieve, treat, or transport casualties – because of this, PPE guidance is provided in Tables 5-F through 5-I and chapters 6-9 of this section.

(2) *General respiratory protection and PPE Levels are recommended herein.* However, the type of respiratory protection and the PPE levels may change based upon actual site conditions, which may change with time and as new information or monitoring comes forth. Therefore, it should be understood that the Incident Commander ultimately decides the level and type of PPE to be worn at the incident site, which depends on the hazard and location at the incident site (i.e., exclusion zone/hot zone, decontamination reduction zone/warm zone, and support zone/cold zone). If MTF personnel go to the incident site, it is expected that they would normally be located in the support zone, where no exposure risk is expected, and first responders would enter the exclusion zone/hot zone to retrieve victims and decontaminate victims in the decontamination reduction zone/warm zone, as necessary, before they are taken to the support zone/cold zone (where they would be handed off to the medical personnel). However, guidance is provided in this Chapter and subsequent Chapters (e.g., CWA, BWA, etc.) in this section should MTF personnel have to enter the exclusion zone/hot zone or decontamination zone/warm zone or have to transport contaminated patients.

(3) *Patient transport to the MTF.*

(A) BWA (after an overt attack) and radiological material.

- The patient should be as clean as reasonably possible before transport, and further contact with contaminants should be avoided. Emergency medical services (EMS) personnel should make arrangements with the local fire department or HAZMAT team to decontaminate (including gross and secondary decontamination) patients, if the situations warrants, before being transported to the MTF. Only decontaminated patients or patients not requiring decontamination should be transported. If secondary decontamination is not possible, patients should, at a minimum, have undergone gross decontamination before being transported by ambulance. If secondary decontamination cannot be performed prior to transport, responders should attempt to prevent the spread of contamination by wrapping the patient loosely but completely in a large blanket or sheet. Contaminated patients and exposed ambulance personnel must be decontaminated upon arrival and before entering the MTF.

- Consult Table 5-G and Chapters 6 and 9 for PPE recommendations.

(B) CWAs and TICs.

- General. Only properly decontaminated patients or patients not requiring decontamination should be transported. Some earlier HAZMAT protocols called for zipping patients into “body bags” without proper decontamination. If patients have been properly decontaminated, no danger of secondary contamination exists. Use of the body bag technique is not effective and may put the victim at risk of substantial skin injury and absorption and is also undesirable for mental health reasons.

- CWA. Detailed guidance for transporting grossly decontaminated victims is not provided in Chapter 7 (CWA terrorism) as is done in the Chapter 8 (TIC Terrorism). The reasoning is that it is critical that the contaminated victims be expeditiously and thoroughly decontaminated to reduce absorption of CWA through the victim’s skin. Because of the extreme toxicity of CWA and the potential for significant absorption through the skin, a thorough decontamination must be done at the incident site, without delay. A thorough decontamination would also reduce the hazard to personnel transporting the victim, whose contaminated skin or clothing could contaminate personnel by direct contact or off-gassing vapor.

- TICs. Patients should be grossly and effectively decontaminated before being transported by ambulance, where possible, and further contact with contaminants should be avoided. If secondary decontamination is not possible, patients should, at a minimum, have undergone gross decontamination before being transported by ambulance. If secondary decontamination cannot be performed prior to transport, responders should attempt to prevent the spread of contamination by wrapping the patient loosely but completely in a large blanket or sheet. Consult Chapter 8 for PPE recommendations. Contaminated patients and exposed ambulance personnel must be decontaminated upon arrival and before entering the MTF.

(4) *PPE for first responders during the initial phase of a release of terrorist agent.* Generally speaking, when the terrorism agent or airborne concentration is unknown, initial first responders entering the exclusion zone will use Level A PPE or Level B PPE, and a lesser level of protection is not deemed acceptable unless air monitoring or a hazard analysis indicates otherwise.

(5) *Transportation HAZMAT Incidents Occurring on Highway or Railroad.* The 2000 Emergency Response Guidebook (ERG) provides a reference for first responders during the initial phase of a dangerous goods/hazardous material incident, including initial isolation and minimum protective action distances and PPE. The ERG provides a quick cross-reference index for ID Numbers, Guide Numbers, and alphabetical listing of names of materials that are then incorporated into a table of initial isolation and minimum protective action distances to the 90th percentile (90% probability that hazard will not exceed these distances). The 2000 ERG is primarily designed for use at a dangerous goods incident occurring on a highway or railroad and therefore it may be of limited value in its application at fixed locations. The web link for the 2000 ERG is <http://hazmat.dot.gov/guidebook.htm>

(6) *Response to a HAZMAT Incident Involving CWA or TICs.* Much of the following was extracted from Reference 69, though some recommendations were modified, changed, or added. There are three concentric areas surrounding a HAZMAT incident:

(A) Hot Zone (or Exclusion Area). The hot zone (or Exclusion Area) is the area surrounding the chemical release; it is assumed to pose an immediate health risk to all persons, including rescuers.

- When a chemical is unidentified, worst-case possibilities concerning toxicity must be assumed and either Level A or B PPE (including pressure-demand SCBAs) worn, depending on the situation. When the chemical is a CWA, Level A PPE should be worn during the initial response.

- Supplied-air respirators (i.e., airline respirator) should not be used because the air hose may be degraded by chemicals or heat, the hose may become tangled, and is also not practical for operations during an emergency.

- APRs are rarely appropriate for emergency response since most HAZMAT incidents involve at least one of the following conditions which would preclude use of an APR: oxygen-deficient atmosphere (<19.5% O₂), unidentified contaminant, unknown concentration of contaminant, concentration of contaminant above the NIOSH IDLH value, and high relative humidity.

(B) Decontamination Zone (or Warm Zone). The Decontamination Zone (or Warm Zone) is the area surrounding the Hot Zone where primary contamination is not expected but where personnel must use protective clothing and equipment to avoid chemical exposure from contaminated victims.

- Generally, the level of PPE is the same as that worn in the Hot Zone, unless professional judgment or air monitoring indicates a lower level of PPE is safe to use. A lower level of protective clothing can be used when the risk of secondary contamination is low. For example, a Level B nonencapsulating suit (NFPA splash protective suit) can be used if a Level A encapsulating suit (NFPA vapor-protective suit) is required in the Hot Zone. If the risk of inhaling off-gassing vapors is also low (i.e., the chemical is not highly volatile or the decontamination area is set up outside with good natural ventilation), it may be acceptable to use a lower level of respiratory protection. Air contaminants should be identified and measured to assure safety before a lesser level of respiratory protection is used.

- Rescuers wearing respirators and heavy gloves will find it difficult to provide advanced medical care such as inserting an intravenous line or performing endotracheal intubation; therefore, this care is not administered until the victim is transferred to the Support Zone. Electronic equipment, such as cardiac monitors, generally is not taken into the Decontamination Zone because the equipment may not be safe to operate and may be difficult to decontaminate.

- Decontamination is not required for all victims. Victims exposed only to TIC gases or vapors that do not have skin or eye irritation generally do not need decontamination. Victims who have been decontaminated or who do not require decontamination should be transferred immediately to the Support Zone.

- If potentially contaminated, EMS personnel must be decontaminated. Many incidents have occurred involving seemingly successful rescue, transport, and treatment of chemically contaminated individuals by unsuspecting emergency personnel who, in the process, contaminate themselves, the equipment, and the hospital where the patient is taken.

- All potentially contaminated patient clothing and belongings that have been removed and bagged should remain in the decontamination area. They should not be transported with the patient in the ambulance unless approved by the Decontamination Officer or Safety Officer.

(C) Support Zone (or Cold Zone). The Support Zone (or Cold Zone) is the outermost ring where no exposure or risk is expected.

- Victims who have been decontaminated or who do not require decontamination are transferred immediately to the Support Zone.

- The incident commander, medical personnel, and other support persons and equipment operate in this zone.

- Only Standard Precautions need be used when interacting with victims when they have been decontaminated or did not require decontamination.

(7) *General decontamination principals and procedures*. Refer to paragraph 5.2.2.A(8)(C) (pages 51-52).

(8) *Air and surface contamination monitoring*.

(A) Air monitoring will help ensure that the PPE used by personnel at the incident site (e.g., in exclusion zone, decontamination reduction zone) is sufficient, or if the PPE needs to be upgraded, or may even be downgraded to a lower level, if so desired.

(B) Decontamination personnel may want to confirm that they have successfully decontaminated the patient before they are released to the support zone. The effectiveness of decontaminating victims of liquid chemical contamination can be done with a combination of methods, such as air monitoring and swipe testing. For instance, with wipe sampling, cloth or paper patches may be wiped over a decontaminated surface or skin, and color changes may be noted which could indicate the possible presence of remaining residual liquid chemical contamination. The presence of beta and gamma radiological contamination can be readily confirmed by passing a radiation detector (radiac) over the entire body (Ref. 55, Ref. 116) – consult Chapter 4 for further information. Air monitoring can detect chemical vapors emanating from any residual liquid contamination remaining on the victim. *Still, some monitoring equipment and methods may not be readily available, operation of some equipment and materials may require skilled operators, in some cases the results may be inconclusive or of limited value, and in some instances, may also possibly complicate and lengthen the decontamination process. However, there are exceptions to this, such as with the use of a radiation detector (radiac), which should be used to detect beta and gamma radiological*

contamination. In most cases, however, the adequacy of decontamination may have to be based exclusively on best clinical judgment and visual observation and by following an effective and established decontamination procedure.

(C) Other references should be consulted for a more thorough discussion of air and surface contamination monitoring (e.g., Ref. 48, Ref. 49, Ref. 51, Ref. 52, Ref. 53, Ref. 55, Ref. 88, Ref. 92, Ref. 116, Ref. 117, Ref. 118, Ref. 119, Ref. 121, Ref. 122, Ref. 123, Ref. 125, Ref. 130, and Ref. 141).

(9) *Firefighting or entering buildings are fire.* When firefighting or entering buildings on fire, structural firefighting gear should be worn – including helmet, SCBA, and turnout gear (thermally insulated coat, pants, and boots). The atmosphere in burning buildings could be oxygen-deficient and have IDLH concentrations of combustion products (e.g., particularly, carbon monoxide, hydrogen chloride, hydrogen cyanide, acrolein, and carbon dioxide). APRs must not be worn in such atmospheres, or death or irreversible health effects may result. Turnout gear must be worn rather than chemical protective clothing, or thermal injury may result.

(10) *Long-term campaigns such as after the terrorist attacks on the World Trade Center (09/11/01) in New York.* In instances of large-scale disaster sites, such as this, body-recovery and clean-up may occur over an extended period of time (e.g., days, weeks, months). Some of the combustion products likely produced (via fires, smoldering) at the World Trade Center are considered TICs, such as carbon monoxide, hydrogen chloride, hydrogen cyanide, and acrolein. Nuclear and radiological terrorism could create a large-scale disaster site of even greater magnitude than what occurred at the World Trade Center. Terrorists could also target and blow up TICs [e.g., nearby industrial, storage, or transportation (e.g., rail, truck, etc.) lines] that might also cause a large-scale disaster site.

(A) Conventional emergency situations, such as building fires, typically require responders to face risks for discrete and short periods of time, usually measured in minutes or hours (Ref. 76). Most PPE and operating procedures are designed for such situations. However, at the World Trade Center, an initial urgent phase persisted for several days and then gradually transitioned into a sustained campaign that lasted for several months (Ref. 76).

(B) For those who had it, structural firefighting gear—including helmet, self-contained breathing apparatus (SCBA) or air pack, and turnout gear (thermally insulated coat, pants, and boots)—worked well for short periods, especially during the initial responses. However, this equipment is not suitable for a sustained campaign (Ref. 76). Fire service helmets are heavy and can hinder performance (Ref. 76). In addition to SCBA being heavy and cumbersome, the facepieces fog, reducing visibility, and the equipment hinders verbal and radio communication (Ref. 76). With limited air in each tank, bottles at the attack sites had to be switched, but many organizations lacked sufficient on-site refill capacity (Ref. 76). Many respirators were uncomfortable, causing “mask face,” which motivated many workers to discard them after short periods or use a lighter dust mask instead (Ref. 76). Firefighters found that the equipment that they had was not comfortable or practical for a long duration (Ref. 76). Turnout gear is heavy and hot, and many responders suffered from fatigue and heat exhaustion (Ref. 76). Wet shoes and socks caused blisters (Ref. 76). Because of the discomfort, responders would

take off their gear whenever they believed they could do so without causing immediate harm, leaving them with no protection at all (Ref. 76).

(C) One of the “lessons learned” recommendations for PPE improvements made by several panels after the terrorist attacks on the World Trade Center (09/11/01) was that atmosphere-supplying or PAPRs were preferred over other respirators (Ref. 76). The reasoning provided was that they put less of the burden on the user’s lungs than non-powered negative-pressure APRs (Ref. 76). Suggestions included exploring full-facepiece models and evaluating how well respirators meet the needs of workers doing strenuous work (Ref. 76). Firefighter panelists recommended that caches (such as those maintained by FEMA) contain ample supplies of boots, gloves, PAPRs, and lighter-weight clothing, such as coveralls. The panel participants also provided another “lessons learned” recommendation regarding respirators, i.e., to have integration of voice diaphragms or emitters in the respirator masks to allow better communication (Ref. 76).

(D) A PAPR equipped with a combination HEPA or P100 filter and organic vapor and acid gas cartridges/canister provides good protection against organic vapors, acid gasses, and aerosols (solid or liquid particles dispersed in air). Also, a non-powered tight-fitting APR (equipped with combination P100 filter and organic vapor and acid gas cartridges/canister) may also provide good protection, but over long-term campaigns, a PAPR might be better tolerated and will likely afford greater protection. However, both are considered APRs and neither may be used in the situations/atmospheres described in paragraph 5.4.4.A(1), situations/atmospheres that would require the use of an SCBA, otherwise death or serious injury may result.

5.3. Standard Precautions. All patients in and outside of healthcare facilities should be managed using Standard Precautions (Ref. 45). However, other precautions may be necessary inside or outside the MTF, such as respiratory protection or other PPE, infection control measures, and where other precautions are necessary, these are identified elsewhere in this document. Standard Precautions are designed to reduce transmission from both recognized and unrecognized sources of infection, and are recommended for all patients receiving care, regardless of their diagnosis or presumed infectious status (Ref. 45). Standard precautions prevent direct contact with all body fluids (including blood), secretions, excretions, nonintact skin (including rashes), and mucous membranes (Ref. 45). Please consult Chapter 14 (Bloodborne Pathogen Program Requirements) in addition to the following.

5.3.1. Handwashing. Hands are washed after touching blood, body fluids, excretions, secretions, or items contaminated with body fluids, whether or not gloves are worn (Ref. 45). Hands are washed immediately after gloves are removed, between patient contacts, between tasks and procedures on the same patient to prevent cross-contamination of different parts of the body, and as appropriate to avoid transfer of microorganisms to other patients and the environment. Either plain or antimicrobial-containing soaps may be used according to local facility policy (Ref. 45).

5.3.2. Gloves (Ref. 45). Clean, non-sterile gloves are worn when touching blood, body fluids, excretions, secretions, nonintact skin, mucous membranes, or items contaminated with such body

fluids. Clean gloves are put on just before touching mucous membranes and nonintact skin. Gloves are changed between tasks and between procedures on the same patient if contact occurs with contaminated material. Hands are washed promptly after removing gloves and before leaving a patient care area.

5.3.3. Masks/Eye Protection or Face Shields. A mask and eye protection (or face shield) are worn to protect mucous membranes of the eyes, nose, and mouth while performing procedures and patient care activities that may cause splashes of blood, body fluids, excretions, or secretions (Ref. 45).

Note 1:

Healthcare workers wear surgical masks as infection control devices to protect the mucous membranes of their mouth and nose from potentially infectious splashes and spatter of blood, body fluids, excretions, or secretions while they are performing procedures and patient care activities that may cause a splash or spatter.

Surgical masks are also used to prevent the spread of infection from the wearer to potentially susceptible person(s). Surgical masks accomplish limited barrier protection by filtering large droplets containing viable microorganisms from the wearer's exhaled breath. For instance, they are sometimes placed on patients that may produce infectious aerosols from their respiratory system in order to reduce the spread of infectious aerosols to healthcare workers. They are also sometimes worn by the healthcare worker to prevent the spread of their respiratory germs to their patient while they are operating on the patient or if the patient is susceptible to infection (e.g., immunocompromised).

Note 2:

A surgical mask can be considered to be a non-sealing air-purifying device having a highly variable aerosol filtration efficiency (Ref. 47). A surgical mask is acceptable to use for the purposes described in Note 1, above. However, a surgical mask is NOT a respirator and must not be used if Airborne Precautions are necessary and the patient's respiratory aerosols present an inhalation risk to the healthcare worker, such as infectious patients having certain diseases that may be transmitted via the airborne route, such as TB, smallpox, or certain VHF's (i.e., Ebola, Lassa, Congo-Crimean HF, and Marburg Viruses). When used in Standard Precautions and Droplet Precautions, surgical masks do have some experimentally and experientially demonstrated efficacy, though a properly fit-tested and fit-checked NIOSH-Certified particulate filtering respirator would afford greater protection; however, the added protection may not be necessary, depending upon the organism, particle concentration and size distribution, and if epidemiological evidence indicates that surgical masks have been successful in preventing droplet infection. The following are reasons why a surgical mask should not be used if respiratory protection is deemed necessary to reduce the risk of inhaling infectious aerosols.

A. Surgical masks are not approved nor tested and certified by any Federal agency for use as a respiratory protection device.

B. Airborne particles will penetrate into (through the filter media) and around the perimeter (through air gaps between the mask and the user's face) of a surgical mask much more so than with a properly fit-tested and fit-checked NIOSH-Certified particulate filtering respirator. Surgical masks are significantly more effective in filtering supermicrometer airborne particles (e.g., > 1 μm AED) than they are in filtering submicrometer particles (< 1 μm AED), since particles > 1 μm AED are readily removed by interception and impaction mechanisms, and the larger they are, the more effectively the particles will be removed.

(1) Particle penetration through the surgical mask filter media is highly variable. Laboratory testing with surgical masks on mannequins has shown that particle penetration through surgical mask filter media is highly variable for airborne particles $< 1\mu\text{m AED}$ (i.e., penetration from 20% to 100%), the filtration efficiency varying depending on the particular surgical mask (Ref. 109). Particle penetration through the surgical mask filter media is significantly less for larger size airborne particles, but is still highly variable (e.g., penetration from about 0.5% to 50% for airborne particles having an AED equal to $4\mu\text{m AED}$), and as with particles $< 1\mu\text{m AED}$, the filtration efficiency varies depending on the surgical mask (Ref. 109). As a comparison, $< 5\%$ of airborne particles will penetrate through a NIOSH-Certified N95 particulate filter, though some N95 respirator filters from manufacturers may have penetration as high as 10% with very small particles (e.g., $0.1\mu\text{m AED}$) (Ref. 25). A NIOSH-Certified Class 100 (e.g., P-100) particulate filter is even more efficient in that $< 0.03\%$ of airborne particles will penetrate through the filter.

(2) Surgical masks are not designed to seal to the face, as are properly fit-tested and fit-checked tight-fitting NIOSH-Certified particulate filtering respirators. Because of this, greater leakage may occur between the air gaps between the surgical mask and wearers face when inhaling, and if there are inhalable infectious aerosols in the air, when the wearer inhales, some of these aerosols will enter through these air gaps rather through the filter. Laboratory testing with surgical masks on mannequins has demonstrated that airborne particle penetration through these gaps is dependent upon the size of the leak, the size of the particle, and the particular surgical mask. The following leak rates were found (Ref. 109): particle of $0.2\mu\text{m AED}$ (leak rate of 20% to 25% ; particle of $1\mu\text{m AED}$ (6% to 20%); and particle of $4\mu\text{m AED}$ (leak rate of 0.5% to 10%). As a comparison, in 95% of users of a properly fit-checked and quantitatively fit-tested NIOSH-Certified N95 particulate filtering half- facepiece respirator, $< 10\%$ leakage is expected to occur between the face and facepiece seal; if the N95 respirator was not fit-tested, leakage could range from 6% to 88%, with 95% of users having leakage less than 33% (Ref. 25). A NIOSH-Certified full-facepiece respirator equipped with Class 100 (e.g., P-100) filters is even more protective in that $< 2\%$ leakage is expected to occur (in the workplace) between the face and facepiece seal if the user achieves a fit factor of 500 in the laboratory and the user properly fit-checks their respirator upon donning it in an uncontaminated atmosphere.

5.3.4. Gowns. A gown is worn to protect skin and prevent soiling of clothing during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, excretions, or secretions (Ref. 45). Selection of gowns and gown materials should be suitable for the activity and amount of body fluid likely to be encountered (Ref. 45). Soiled gowns are removed promptly and hands are washed to avoid transfer of microorganisms to other patients and environments (Ref. 45).

5.3.5. Soiled PPE. Promptly remove soiled PPE. Clean and disinfect reusable PPE before reuse. Properly dispose of single-use items.

5.3.6. Sharps (needles or other sharp objects). Use care when handling sharps (Ref. 48). The primary route of exposure to bloodborne pathogens is accidental percutaneous injury caused by puncturing of the skin by a needle or similar sharp object (Ref. 86).

5.3.7. Resuscitation (Ref. 48). Use a mouthpiece or other ventilation device as an alternative to mouth-to-mouth resuscitation when practical (Ref. 48).

5.3.8. Equipment and Linen. Handle used patient-care equipment and linen in a manner that prevents the transfer of microorganisms to people or equipment (Ref. 48). This would include proper handling and processing of soiled linen; cleaning and disinfecting or sterilizing of reusable patient-care equipment, and routine cleaning and disinfecting of environmental surfaces.

5.3.9. Isolation. Place patients whose blood or body fluids are likely to contaminate surfaces or other patients, in an isolation room or area.

5.4. General Information Regarding PPE for Use in CBRN Situations.

5.4.1. PPE Levels (A, B, C, and D). There are four PPE Levels (A, B, C, and D) that provide different levels of protection, and these various levels are recommended throughout this technical guide, depending on the situation, and whether response personnel are at the MTF, transporting victims in an ambulance, or at the incident site. It should be noted, however, that the Incident Commander (at incident site) or health and safety personnel (at the MTF) determine the appropriate level of PPE, which can change as more information about the hazards and conditions at the site becomes available.

A. OSHA/EPA. Appendix C provides a general description and discussion of the OSHA/EPA PPE levels used in hazardous waste operations and emergency response, as extracted from Appendix B of the OSHA Hazardous Waste Operations and Emergency Response regulation, 29 CFR 1910.120. The OSHA/EPA PPE Level descriptions apply to how an ensemble is designed, not its performance; on the other hand, the NFPA has classified hazardous materials protective ensembles by their performance in three standards – see paragraph 5.4.3. The OSHA/EPA levels of protection should be used only as the starting point when assembling a protective ensemble. The OSHA standard requires that PPE be selected which will protect employees from the specific hazards that they are likely to encounter. However, the equipment specified within the OSHA/EPA PPE Levels are guidelines and some of the equipment indicated within a specific PPE level are designated as optional and may not be necessary, depending on the situation. Also, site information may suggest the use of combinations of PPE selected from the different protection levels as being more suitable to the hazards of the work.

B. InterAgency Board (IAB) for Equipment Standardization and Interoperability. Appendix D provides a standardized equipment list for personal protective equipment used for interagency response operations in combating WMD terrorism. It is a guideline and some of the equipment indicated within a specific PPE level may not be necessary, depending on the situation and whether personnel are at the MTF or at the incident site.

C. Program Requirements. Chapter 12 provides OSHA's PPE regulatory requirements, including selection, use, and training.

5.4.2. Hazard Assessment and Threat Analysis. A hazard assessment and threat analysis should be completed by emergency response and health and safety organizations for their jurisdictions. Respiratory protective equipment and protective ensembles should be procured based upon their ability to protect against the potential hazards and threats.

5.4.3. Protective Ensembles.

A. Commercial Protective Ensembles Should be Certified to Meet NFPA Standards.

Acceptable types of chemical protective clothing include totally encapsulating and non-encapsulating ensembles offering specific levels of vapor and/or liquid hazard threat protection. The NFPA has classified hazardous materials protective ensembles by their performance in three (3) standards:

(1) *NFPA 1991 Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies (1994, 2000 latest edition)*. This is equivalent to OSHA/EPA Level A protective ensembles. Includes protective garments, gloves, and footwear; respiratory protection is not addressed as part of this standard.

(2) *NFPA 1992 Standard on Liquid Splash-Protective Clothing for Hazardous Materials Emergencies (1994, 2000 latest edition)*. This is equivalent to OSHA/EPA Level B protective ensembles. Includes protective garments, gloves, and footwear; respiratory protection is not addressed as part of this standard.

(3) *NFPA 1994 Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents (July 2001)*. This is a very recent standard and it is conceivable that the US Army may be driven to use this standard in the near future for commercial PPE selection. Ensembles that are certified to this standard are expected to be available in late 2002 or 2003. This standard applies to certification of three classes (based on incident risk analysis) of protective ensembles (includes protective garments, gloves, and footwear; respiratory protection is not addressed as part of this standard) against terrorism with CWAs, TICs, and BWAs, but does not apply to radioactive material, firefighting, etc. The NFPA 1994 standard does not apply to any protective ensembles manufactured before 2 August 2001 that were intended for use in chemical/biological terrorism incidents. Because of the events of September 11, 2001 and ongoing terrorism threats, NFPA has provided NFPA 1994 (2001), other relevant NFPA standards, and Supplements from NFPA's best-selling *Hazardous Materials Response Handbook* at the following website: <http://www.nfpa.org/Codes/codesandstandards/hazmat/hazmat.asp>

NOTE: Chemical protective clothing would also provide barrier protection against both BWA and nuclear and radiological particulates.

NOTE: The following website provides a list of PPE certified by the Safety Equipment Institute (SEI) as meeting standards, such as NFPA 1991, 1992, and 1994:
<http://www.seinet.org/CPL/contents.htm>

B. Chemical Protective Gloves for Use Against CWAs or TICs.

(1) MTF personnel interacting with potentially CWA or TIC contaminated victims should wear chemical protective gloves, such as a butyl rubber glove worn over an inner disposable nitrile glove. Butyl rubber gloves come in various degrees of thickness (e.g., 7-mil, 14-mil, 17-mil, 25-mil, 30-mil), and the thicker the glove, the greater the protection, but also the

greater the loss of manual dexterity. A minimum of 14-mil is recommended. Disposable nitrile gloves are relatively thinner and also come in various degrees of thickness (e.g., 4-mil, 5-mil).

(2) Users of heavy gloves may find it difficult to provide advanced medical care, such as inserting an intravenous line or performing endotracheal intubation (Ref. 69). Hendler et. al. (2000) conducted a study to determine the effect of full protective gear (included 12-mil “tactile” gloves and Israeli full-facepiece air-purifying M-15 military NBC protective mask) on intubation performance by hospital medical personnel, and found that endotracheal intubation could still be performed effectively (i.e., the tube was inserted in sufficient time), though the protective gear caused a significant prolongation of intubation duration (which might be responsible for a delay in decontamination and antidotal therapy) (Ref. 139).

(3) Another possible issue may be that of maintaining sterility, meeting FDA requirements for exam gloves, and changing gloves after touching each patient.

(4) In conclusion, MTF personnel interacting with potentially CWA or TIC contaminated victims should wear chemical protective gloves, such as a 14-mil (or greater) butyl rubber glove worn over an inner disposable nitrile glove (4- or 5-mil). However, some advanced medical care procedures (e.g., endotracheal intubation) may have to be conducted before the victim is decontaminated and it may possibly be too difficult to effectively conduct these procedures with a combined glove thickness of 19-mil. So, for these procedures, it may be necessary to use a butyl rubber glove of 7-mil or 14-mil without an inner nitrile glove. If there is a concern for maintaining sterility while conducting advanced medical procedures and these procedures cannot wait until the patient is decontaminated, double gloving with disposable 4- to 5-mil nitrile gloves may be necessary. However, it is very important that the disposable nitrile gloves be changed frequently, for example, every ½ hour (after physically contacting a potentially contaminated person) and between touching patients - this should provide sufficient protection against the nerve agent GB and blister agent HD, according to the data indicated in reference 52e, and would provide protection against certain TICs. However, it should also be understood that butyl rubber gloves would generally provide better protection than the nitrile gloves for CWA and most of the TICs identified in Appendix H, though sometimes the converse applies. Also, of note, is that nitrile rubber is very effective for protection against certain TICs not on the list in Appendix H, such as n-hexane, cyclohexane, diesel fuel, kerosene fuel, jet fuel, Naptha, whereas butyl rubber provides very poor protection against these substances and should not be used for protection against them.

C. Rubber Gloves for Use Against BWA or Nuclear/Radiological Contamination. Either surgical gloves or chemical protective gloves may be used for protection. However, where T-2 mycotoxin is involved, use the chemical protective gloves as recommended for TICs and CWA.

5.4.4. Respiratory Protection.

A. APRs (Figure 13-A). Consult Chapter 13 for a description of various requirements for respiratory protection devices, including prior medical approval, fit-testing, and training.

(1) *General restrictions.* An APR may be used by those at the incident site or those interacting with contaminated patients at the MTF, in order to protect against airborne exposures that may exceed occupational exposure limits. However, an air-purifying respirator cannot be used if any of the following situations apply:

- (A) Atmospheres containing chemical concentrations that are IDLH.
- (B) Atmospheres that are oxygen-deficient.
- (C) Filter, cartridge, or canister does not effectively remove the chemical.
- (D) Airborne concentrations exceed the MUC for the respirator.
- (E) Firefighting.

(F) First response to accidents or terrorist incidents where chemical concentrations are unknown or suspected of being higher than what an APR would provide sufficient protection against.

(2) *NIOSH-Certified Respirators.*

(A) A minimum of Level C with an APR is sometimes recommended in this document depending upon the situation and whether the terrorist event involves CWAs, TICs, BWA, or nuclear and radiological material. However, practically speaking, MTFs should procure APRs that will protect against each of these scenarios, since it will be impractical to have different respirators with differing filtering or adsorbent abilities to be chosen from when a terrorist event occurs. For instance, where Level C PPE is recommended in this guide, APRs should be procured that are NIOSH-Certified and equipped with a combination of HEPA or P-100 filters and organic vapor/acid gas cartridge(s) or canister(s). The HEPA or P-100 filters will remove particulate aerosols (e.g., biological or radiological particulate) and liquid aerosols (e.g., TIC or CWA). The organic vapor/acid gas cartridges or canisters will remove organic vapors and acid gases, respectively. However, the manufacturer literature must be consulted for the cartridge or canister effectiveness against specific CWAs and specific TICs, and the cartridges or canisters must be changed before chemical breakthrough occurs. That is, the chemicals will break through the cartridges or canisters if the adsorbent material is over saturated. The time of breakthrough can occur depending on the chemical contaminant, the chemical concentration, the persons breathing rate, the amount of air the person breathes through the cartridges or canister, the relative humidity, and the temperature. Because of this, when an APR is used to protect against gases or vapors, they must be either equipped with an End of Life Service Indicator (ESLI) certified by NIOSH for the contaminant, or the canisters or cartridges must be changed before the end of their service life (based upon objective information or data).

(B) At this stage, there are no APRs that NIOSH has certified against the broad spectrum of potential terrorist agents, including CWA, BWA, Radiological/Nuclear agents, and TICs; however, NIOSH published broad spectrum certification requirements for non-powered APRs in spring 2003. Likewise, NIOSH will also be developing such broad-spectrum

certification for PAPRs and it is anticipated that it will be published in mid to late 2003. The availability of commercial APRs that are NIOSH certified against the broad spectrum of potential terrorist agents would presumably follow after NIOSH publishes their standards. APRs that are NIOSH approved for use against the broad spectrum of potential terrorist agents should be used when these become commercially available.

(C) The following website provides a list of commercial respirators approved by NIOSH for use against specified hazards: <http://www.cdc.gov/niosh/celintro.html>

(3) *M40-Series Military Protective Mask*, <http://www.sbccom.apgea.army.mil/products/m40.htm>.

(A) The M40-Series Military Protective Mask should not be used by personnel from fixed-facility military MTFs in response to handling casualties from weapons of mass destruction and terrorism events, be they CWA, BWA, Radiological/Nuclear agents, or TICs. Though the M40-Series Military Protective Mask provides very effective protection against CWA, BWA, Radiological/Nuclear agents, and some TICs, it should not be used for planning purposes by the MTFs for the reasons outlined below.

(B) The M40-Series Military Protective Mask was designed to be used by soldiers in tactical situations against various potential warfare agents on the battlefield, including CWA, BWA, Radiological/Nuclear agents, and some TICs that are also considered CWA. The filters of the M40-Series mask are tested according to military specification and are required to provide protection against other CWAs besides nerve and blister agents, such as blood agents (hydrogen cyanide, cyanogen chloride), choking agents (phosgene, chloropicrin), and riot control agents (orthochlorobenzyleidene malonitrile, CS; chloroacetophenone, CN). The blood agents, hydrogen cyanide and cyanogen chloride, and the choking agent, phosgene, are also considered TICs, as indicated in Appendix H. The M40-Series Military Protective Mask is very effective in providing protection against the substances indicated in this paragraph. Also, recent breakthrough simulation studies by the Army have shown that the filter to the M40 to be “effective” against about one-third of the TICs in Appendix H (Ref. 154).

(C) The following reasoning is provided for not allowing the use of the M40-Series Military Protective Mask by personnel from fixed-facility military MTFs in response to handling casualties from weapons of mass destruction and terrorism events:

- It is not NIOSH-Certified, as required by OSHA and DA regulations and Department of Defense Instructions (DoDIs). The principle reason the M40-Series mask does not meet NIOSH testing and certification standards is that the M40-Series mask does not meet exhalation and inhalation breathing resistance standards, which may make it a little more difficult to breathe through than a NIOSH-Certified Respirator, but this does not impair its effectiveness.
- Except for the blood agents, hydrogen cyanide and cyanogen chloride, and the choking agent, phosgene, it was not generally designed for use against the TICs identified in Appendix H and may not provide effective protection against as broad a range of TICs

as do commercially available APRs that were specifically designed to provide protection against TICs.

- It is anticipated that non-powered APRs that are NIOSH-Certified against the broad spectrum of potential terrorist agents, including CWA, BWA, Radiological/Nuclear agents, and TICs should be commercially available very soon (i.e., in the second half of 2003). And, PAPRs that are NIOSH-Certified against the broad spectrum of potential terrorist agents are anticipated to be available in early 2004.

- Though NIOSH has not yet certified APRs against the whole spectrum of CBRN families (i.e., TICs, CWA, BWA, Nuclear/Radiological) and these respirators are not available at the time of this publication, in the interim, commercial APRs are available on the market that will provide effective protection against TICs, CWA, BWA, and Nuclear/Radiological agents. For instance:

- + Commercial APRs are available and NIOSH-Certified for a wide variety of TICs, including general classes of chemicals, such as organic vapors and acid gasses, and specific TICs (e.g., chlorine, ammonia, formaldehyde, hydrogen chloride, hydrogen cyanide, hydrogen fluoride, hydrogen sulfide, nitrogen dioxide, phosphine, and sulfur dioxide).

- + Commercial APRs (e.g., equipped with HEPA or P-100 filter) are available that are NIOSH-Certified against “dust, fumes, mists, and radionuclides” and “radon daughters.” Though there are no NIOSH-Certified APRs specifically certified for protection against biological agents, particulate filter (e.g. HEPA, P-100, etc.) respirators have been historically used for protection against biological agents under some circumstances (i.e., when an APR was considered acceptable respirator protection). The testing in the future to have an APR NIOSH-Certified against the biological and radiological/nuclear portion of the CBRN certification is anticipated to involve testing with a non-biological and non-radiological aerosol (e.g., corn oil aerosol at a specified diameter and concentration), testing which would be no different than has been done in the past for particulates.

- + Though there are currently no commercially available APRs that are NIOSH-Certified for protection against CWA, commercial respirators (non-powered and powered APRs) are available that have been tested (using military specifications) and found to be effective against CWAs, as well as also being NIOSH-Certified against some TICs (e.g., organic vapors, etc.) and “dust, fumes, mists, and radionuclides and “radon daughters,” and contain filters (e.g., HEPA, P-100) that would also be effective against BWA.

- + Lastly, the scope/context of this technical guide is restricted to fixed-facility military MTFs and not to tactical (i.e., of or relating to combat tactics, including mobile field-based MTFs in combat) situations where the M40-Series Military Protective Mask would be used. It is expected that at a small percentage

of fixed-facility military MTFs, some military personnel assigned to the MTF may also be deployable and would either have been issued an M40 or issued one at the time of their deployment. These individuals should not use their M40-Series Military Protective Mask in lieu of a NIOSH-Certified respirator within the scope/context of this technical guide.

B. Atmosphere-supplying respirators (Figure 13-B).

(1) Where an SCBA is used, they will be NIOSH-certified for use against Chemical, Biological, Radiological, Nuclear (CBRN) Agent. NIOSH-certified SCBAs for use against CBRN can be found at the following website: <http://www.cdc.gov/niosh/npptl/cbrncheck.html> This is a new NIOSH certification program. NIOSH began accepting applications for SCBA certification against CBRN on January 22, 2002, and there are now NIOSH approved SCBAs for use against CBRN. The new program incorporates performance criteria for SCBAs from the traditional program, and augments them with additional criteria pertinent to situations in which chemical, biological, and other agents may be used, as weapons of terror and hazards may be difficult to predict. For example, SCBAs must also meet NFPA standards for heat- and flame-resistance, and must be resistant to chemicals that may be used as weapons, as determined by laboratory tests involving the chemical warfare agents sarin and mustard gas. SCBAs that have been approved under the existing program for use in traditional work settings will not need to be re-submitted for approval under the new program, if they are not intended for use by first responders against CBRN agents. For further details, go to the following NIOSH website: <http://www.cdc.gov/niosh/npptl/scbasite.html>

(2) When a chemical is unidentified at the incident site, worst-case possibilities concerning toxicity are usually assumed by first responders while working in the exclusion zone and either Level A or B PPE is usually worn, depending on the situation. The potential for severe local effects (e.g., irritation and burning) and severe systemic effects (e.g., organ damage) should be assumed when specific rescuer-protection equipment is selected. Pressure-demand, SCBA should be used in all first response situations to protect the respiratory system and chemical-protective clothing to protect the skin. Supplied-air respirators (i.e., airline respirator) should not be used at the incident site because the air hose may be degraded by chemicals or heat, and is also not practical for operations during an emergency (e.g., air hose may become tangled, limited mobility, the air hose may not be long enough, etc.).

(3) At the MTF, airline respirators may be used instead of SCBAs where Level B is recommended in this guide for decontamination. It is anticipated that NIOSH will have a certification standard for airline respirators specifically for use against CBRN agent by the end of 2003. Airline respirators that are NIOSH Approved for use against CBRN will be used when these become commercially available.

5.4.5. Additional Information to Help Select PPE. Consult this chapter, specific chapters for each of the terrorist agents, and the following information, as applicable.

A. CWA, TIC, and BWA Specific. An overview of types of respirators and other PPE, selection factor considerations, and an evaluation of manufacturer PPE against CWA, TIC, and BWA protection can be found in the Guide for the Selection of Personal Protective Equipment

for Emergency First Responders, NIJ Guide 102-00 (Volumes I, IIa, IIb, and IIc) Working Draft (Ref 65). A website link to this guide can be found at: <http://www.ojp.usdoj.gov/nij/pubs-sum/191518.htm>

B. CWA and TIC Specific. The Agency for Toxic Substances and Disease Registry (ATSDR) provides a guide titled Managing Hazardous Material Incidents (Ref 69). Volume I is regarding Emergency Medical Services (A Planning Guide for the Management of Contaminated Patients); Volume 2 is regarding Hospital Emergency Departments (A Planning Guide for the Management of Contaminated Patients), and Volume III is regarding Medical Management Guidelines for Acute Chemical Exposures, including CWAs, TICs, and other chemicals. The web site link for each of these volumes is as follows: <http://www.atsdr.cdc.gov/mhmi.html#V3>

C. CWA Specific.

(1) Appendix G provides a list of commercially available Level A, B, and C PPE (clothing and respirators) for use against CWAs that have been approved by the U.S. Army Materiel Command Chemical Agent Safety and Health Policy Action Committee (CASHPAC). This list will be updated with time.

(2) The following website provides test results of protective clothing and respirators against CWA, <http://hld.sbcom.army.mil/ip/reports.htm>

(3) The following website provides a link to the DOD-NIOSH-OSHA Sponsored Chemical and Biological Respiratory Protection Workshop, <http://www.cdc.gov/niosh/pdfs/2000-122.pdf>

(4) The airborne exposures limits and IDLH concentrations in reference 4 (Tables 2-2 and 2-3) should be considered when selecting respirators to be used for those at the incident site or at the MTF. The appropriate respirator must be worn when airborne exposure limits and IDLH concentrations are exceeded and when the atmosphere is oxygen-deficient.

- Only atmosphere-supplying respirators are allowed when entering an atmosphere that is considered IDLH or oxygen-deficient. APRs are not allowed when entering an atmosphere that is considered IDLH or oxygen deficient, otherwise death or permanent adverse health effects may result. It is possible that IDLH or oxygen-deficient conditions may exist at the incident site, depending on the circumstances.

- Oxygen-deficiency is not a concern at the MTF, unless perhaps the MTF is part of the incident site. With regard to the inhalation hazard that may exist to MTF personnel when they interact with contaminated patients at the MTF, it is possible that exposures might exceed the airborne exposure limits in some circumstances, but it is probably unlikely that IDLH concentrations would be exceeded, unless perhaps the MTF is part of the incident site.

D. TIC Specific.

(1) *Incident site.*

(A) The following exposure limits should be considered when selecting respirators to be used by first responders at the incident site. The appropriate respirator must be worn when *Permissible Exposure Limits (PELs)*, *Threshold Limit Values (TLVs)*, or *Workplace Environmental Exposure Levels (WEELs)*, and *IDLH* concentrations are exceeded.

- *IDLH* concentrations, as published by the NIOSH (Ref. 22, Ref. 23). Only atmosphere-supplying respirators are allowed when entering an atmosphere that is considered IDLH. APRs are not allowed when entering an atmosphere that is considered IDLH, otherwise death or permanent adverse health effects may result.
- *PELs*, as published by OSHA (Ref. 14).
- *TLVs*, as published by the American Conference of Governmental Industrial Hygienists (ACGIH) (Ref. 18, Ref. 19).
- *WEELs*, as published by the American Industrial Hygiene Association (AIHA) (Ref. 101, Ref. 102).

(B) Only atmosphere-supplying respirators are allowed when entering an atmosphere that is considered oxygen-deficient. APRs are not allowed when entering an atmosphere that is considered oxygen-deficient, otherwise death or permanent adverse health effects may result.

(C) The AIHA Emergency Response Environmental Exposure Level Guides (ERPGs) are one-hour planning guidelines to protect the general public (and workers) from the consequences of accidental chemical releases (Ref. 101). The ERPGs should be considered in instances of terrorism with TICs.

(2) *MTF*.

(A) If the patients are victims of a gas or vapor, it is highly unlikely that the patients would present an inhalation hazard to the MTF personnel interacting with them at the MTF. However, patients arriving at the MTF that have liquid TIC contamination on them may pose an inhalation hazard to those MTF personnel interacting with them. Still, though an inhalation hazard may exist, it is extremely unlikely that vapor concentrations evaporating from patients contaminated with liquid TICs would ever pose an IDLH inhalation threat to those MTF personnel interacting with them at the MTF, unless perhaps the MTF is part of the incident site.

(B) Oxygen-deficiency is not a concern at the MTF, unless perhaps the MTF is part of the incident site.

(C) The following exposure limits should be considered when selecting respirators to be used by MTF personnel when interacting with victims of liquid contamination. The appropriate respirator must be worn when *PELs*, *TLVs*, or *WEELs*, and *IDLH* concentrations are exceeded.

- *PELs*, as published by OSHA (Ref. 14).
- *TLVs*, as published by ACGIH (Ref. 18, Ref. 19).
- *WEELs*, as published by the AIHA (Ref. 101, Ref. 102).

E. Nuclear and Radiological Terrorism Specific. Consult Chapters 4 and 9 for guidance.

F. BWA Specific.

(A) General considerations in selecting respiratory protection against BWAs that may cause infection and disease when inhaled.

(1) Ideally, the selection of the type of respirator for protection against infectious aerosols should consider the probability of acquiring an infection, the historical/epidemiological record with regard to the ability of specific PPE to prevent secondary transmission, the severity of the disease (e.g., lethality rate, etc.), and availability and use of an effective vaccine or other prophylaxis. The probability of infection via inhalation is based upon the dose inhaled (including where the agent deposits in the respiratory tract), infectious dose of the agent (depends on the person's immune system, vaccination status, nutritional status, stress, age, particle size, etc.), and the respirator APF.

(2) Respiratory protection will reduce the risk of infection when exposed to infectious aerosols but may not altogether eliminate the risk, since some leakage may still occur into the mask (e.g., through the filter media or between the facepiece seal and users face). Though leakage may occur, the dose inhaled will be reduced and the probability of infection will subsequently be reduced; if the dose inhaled through respirator leakage is less than the infectious dose, then the risk is effectively eliminated. Some efforts have been made to develop risk-based methods for selection of respiratory protection against infectious aerosols. These methods estimate the probability of infection depending upon the respirator used (and the associated leakage and protection factor), infectious dose of the BWA, the estimated dose inhaled, etc.. For instance, Nicas (2000) proposed a risk-based method to select respiratory protection against anthrax spores and AIHA/ANSI (2002) are in the process of developing risk-based methods for respiratory protection for use against infectious aerosols, in general (Ref. 143, 156). (Note: though, in theory, this may be the ideal way to select respirators against BWA, it is possible that it may not necessarily be practical or realistic at the present time.)

(3) The minimum respiratory protection against infectious aerosols is provided by a tight-fitting Class N-95 particulate half-facepiece air-purifying respirator. Using more protective respirators can lower the risk of infection more. For instance, as a general rule of thumb, a tight-fitting full-facepiece APR will provide more protection than a half-facepiece APR, a tight-fitting full-facepiece PAPR provides more protection than a non-powered full-facepiece APR, and an atmosphere-supplying respirator (e.g., SCBA, airline) will provide more protection than a tight-fitting full-facepiece PAPR. Regarding the air-purifying particulate filter media used in today's respirators, Class 100 particulate filters provide a higher level of filtration

efficiency than do Class 99 and Class 95 particulate filters, and Class 99 filters provide a higher level of filtration than does a Class 95 filter. Note: A P-100 filter is equivalent to a HEPA filter.

(4) Selecting the appropriate level of respiratory protection for protection against a BWA requires many considerations. For instance, though a higher level of respiratory protection may be ideal in some situations, it may not be practical since healthcare providers must balance the need to reduce the risk to themselves and provide necessary healthcare to the patient.

(5) At some point (as the science and expert consensus develops), USACHPPM may provide updated recommendations, which take into account all of the above considerations, and those of paragraph 1.2. Until then, however, follow the guidance provided in Chapter 6 and applicable appendices.

(B) Other guidance. Consult Chapter 6 for further PPE guidance.

5.5. General PPE Selection.

5.5.1. OSHA Website Links. The following OSHA website links provide guidance related to selection of PPE and Respiratory Protective Equipment and other relevant subjects that have recommendations and/or requirements regarding respiratory protection and other PPE:

- A. Respiratory protection: <http://www.osha.gov/SLTC/respiratoryprotection/index.html>
- B. Personal Protective Equipment: <http://www.osha.gov/SLTC/personalprotectiveequipment/index.html>
- C. Hospital Emergency Response: <http://www.osha.gov/Publications/OSHA3152/osha3152.html>
- D. Emergency Response: <http://www.osha.gov/SLTC/emergencyresponse/index.html>
- E. Bloodborne Pathogens: <http://www.osha.gov/SLTC/bloodbornepathogens/index.html>

5.5.2. NIOSH Website Links.

- A. Respirators.
 - (1) *Respirator site with various links*: <http://www.cdc.gov/niosh/respinfo.html>
 - (2) *Guide to Industrial Respiratory Protection*: <http://www.cdc.gov/niosh/87-116.html>
 - (3) *Guide to the Selection and Use of Particulate Respirators*:
<http://www.cdc.gov/niosh/userguid.html>
 - (4) *TB Respiratory Protection Program in Health Care Facilities - Administrator's Guide*: <http://www.cdc.gov/niosh/99-143.html>
- B. Chemical Protective Clothing.

(1) A Guide for Evaluating the Performance of Chemical Protective Clothing:
<http://www.cdc.gov/niosh/90-109.html>

(2) Recommendations for Chemical Protective Clothing, A Companion to the NIOSH Pocket Guide to Chemical Hazards: <http://www.cdc.gov/niosh/ncpc1.html>

5.5.3. Certified Commercial PPE.

A. Respirators. The following website provides a list of commercial respirators approved by NIOSH for use against specified hazards: <http://www.cdc.gov/niosh/celintro.html>

B. Other PPE. The following website provides a list of PPE certified by the Safety Equipment Institute (SEI) as meeting specific standards (e.g., NFPA, ANSI, ASTM):
<http://www.seinet.org/CPL/contents.htm>

SECTION II: PPE SELECTION

CHAPTER 6: BIOLOGICAL WARFARE AGENT TERRORISM

6.1. General.

6.1.1. Acronyms and terms. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

6.1.2. References. A list of references cited in this Chapter can be found in Appendix B.

6.1.3. Background information. Before reading this Chapter, readers should review Chapter 1 for background information on biological warfare agent (BWA) terrorism.

6.1.4. Pictures of Personal Protective Equipment (PPE) Levels and Respirators.

A. PPE Levels. On the cover page, there is a picture of a simulated decontamination of a victim at an incident site. Personnel in Level A PPE have delivered a non-ambulatory victim from the exclusion zone to two people performing decontamination in Level B PPE in the decontamination reduction zone. Level C PPE would look similar to Level B PPE except an air-purifying respirator (APR) is worn instead of an atmosphere-supplying respirator, such as the Self-Contained Breathing Apparatus (SCBA) worn by those in this picture.

B. Respirators. Figures 13-A and 13-B provide pictures of air-purifying and atmosphere-supplying respirators, respectively.

6.1.5. PPE selection. It is essential that readers review Chapter 5 (Introduction and General PPE Selection Information) before reading this Chapter.

6.1.6. Program requirements. Section III provides program requirements for PPE use.

6.2. PPE Guidelines For Handling Patients Arriving at the MTF.

6.2.1. General Care of Patients inside the MTF.

A. It is assumed that patients that were victims of an overt bioterrorism attack will have been adequately decontaminated before entering the MTF. These patients are not likely to present with symptoms of the disease nor be contagious because of the incubation periods for BWAs. Patients that were victims of a covert bioterrorism attack will likely have presented themselves at the MTF with symptoms of the disease days after the bioterrorist attack, so the need for decontamination is minimal or nonexistent (Ref. 43, 45, 48).

B. All patients in healthcare facilities, including symptomatic patients with suspected or confirmed bioterrorism-related illnesses, should be managed using Standard Precautions (Ref. 45) – see paragraph 5.3. If a victim of bioterrorism develops a disease caused by an agent, the disease may or may not be transmitted from person to person – see paragraph 1.2.2 (pages 10-11).

C. The Infection Control Precautions (including PPE recommendations) in Tables 6-A through 6-D are for healthcare workers caring for patients suspected or confirmed as having a disease caused by a bioterrorism agent.

Table 6-A: Viral Hemorrhagic Fevers

Disease/ Etiologic Agent	Infection Control Precautions (Including PPE)
Viral hemorrhagic fevers (VHFs). Note: The VHFs are a diverse group of illnesses caused by RNA viruses from four viral families. Refer to Chapter 1 for the viruses responsible for various VHFs.	1. Standard, Contact, and Airborne Precautions, and other precautions as indicated below with any patient with suspected or documented VHF (Ref. 100). Lassa, Congo-Crimean HF, Ebola, and Marburg viruses may be particularly prone to aerosol nosocomial spread (Ref. 48). Only Standard Precautions are necessary for some HF's (e.g., Yellow Fever and Dengue HF, Ref. 149), so Contact and Airborne Precautions, as well as the paragraphs below do not apply to these diseases. 2. Minimum recommended respiratory protection when entering the patient room is a NIOSH approved N95 particulate respirator (Ref. 100). Other recommended PPE when entering the patient room are goggles or face shield; an <u>impermeable</u> gown; <u>double</u> gloves; <u>shoe and leg</u> covers, given the copious amount of infected material, such as vomitus and liquid stool that may be present in the environment (Ref. 100); and, head covers (Ref. 48). Some experts have recommended that a PAPR be worn during cough-inducing procedures (e.g., endotracheal intubations, bronchoscopies), and during autopsies - however, because this may increase the chance of injuries with sharps, individuals using PAPRs must be especially careful when handling sharps (Ref. 100). Note 1: According to Borio et. al. (2002), they concur with recommendations by others that PAPRs should be worn (rather than N95 respirators) during cough-inducing procedures (i.e., endotracheal intubations, bronchoscopies), autopsies, and centrifugation or pipetting of laboratory specimens, as long as this does not increase the risk of inadvertent needlestick injury (Ref. 100). Note 2: Since 1967, there have been 18 reports of human outbreaks of VHF secondary to Ebola or Marburg viruses, resulting in approximately 1500 cases to date (Ref. 100). Epidemiological investigation indicates that most cases occurred after <u>direct contact</u> with blood, secretions, or tissues of infected patients or nonhuman primates (Ref. 100). Indirect contact via person-to-person airborne transmission of HFVs appears to be a rare event but cannot be conclusively ruled out (Ref. 100). Given the inability to completely exclude this potential, the lack of preventive vaccines, and, in the case of filoviruses (e.g., Ebola, Marburg), the lack of effective drug therapy, respirators should be worn when entering the VHF patient's room (Ref. 100). Note 3: The VHFs are a diverse group of illnesses caused by RNA viruses from four viral families, but in all, the target organ is the vascular bed – microvascular damage and vascular permeability leading to hemorrhage and edema (Ref. 48). These viruses are spread in a variety of ways. With the exception of dengue and hantaviruses, VHF patients generally have significant quantities of virus in their blood and often in other secretions. Therefore, sharps must be carefully handled and standard precautions strictly adhered to, to prevent potentially infectious fluids from infecting the healthcare provider. The later stages are most transmissible, because there is lots of bleeding and titers are high in the blood and other secretions. Lassa, Congo-Crimean HF, Ebola, and Marburg viruses may be particularly prone to aerosol nosocomial spread. Not all infected patients develop VHFs. 3. There must be <u>strict</u> adherence to hand hygiene (Ref. 100): Health care workers should clean their hands prior to donning personal protective equipment for patient contact. After patient contact, health care workers should remove gown, leg and shoe coverings, and gloves and immediately clean their hands. Hands should be clean prior to the removal of facial protective equipment (i.e., personal respirators, face shields, and goggles) to minimize exposure of mucous membranes with potentially contaminated hands, and once again after the removal of all personal protective equipment. 4. Use dedicated medical equipment, such as stethoscopes, glucose monitors, and, if available, point-of-care analyzers (Ref. 100).

Table 6-B: Smallpox

Disease/Etiologic Agent	Infection Control Precautions (Including PPE)
Smallpox, <i>Orthopoxvirus</i> genus, variola species	Standard, Contact, and Airborne Precautions for care of patients, including post-mortem care. Only personnel that have been successfully vaccinated (IAW DoD Smallpox Response Plan, Ref. 155) and are wearing a minimum of a NIOSH-approved N95 respirator should be permitted to enter the patient room or handle items potentially contaminated by infectious lesions. Shoe covers should also be worn to prevent transportation of the virus outside of patient isolation areas. Personnel should wear appropriate barriers (e.g., gloves, gown, and respiratory protection) when handling items potentially contaminated by infectious lesions (Ref 45). Note 1: Clinical manifestations begin acutely with malaise, fever, rigors, vomiting, headache, and backache (Ref. 51). Two to 3 days later, an enanthem appears concomitantly with a discrete rash about the face, hands, and forearms (Ref. 51). Owing to the lack of a keratin layer on mucous membranes in the oropharynx, lesions there shed infected epithelial cells and give rise to infectious secretions from the mouth in the first days of the eruptive illness (Ref. 51). The rash can appear in the mouth even before it appears on the body, and can be infectious then. These respiratory secretions are the most important but not the sole means of virus transmission to contacts (Ref. 51). Patients should be considered infectious until all scabs separate (Ref. 48), which is about 3 weeks (Ref. 45). Note 2: The guidance to wear a minimum of an N95 respirator (even if successfully vaccinated) is made to keep the guidance simple and is also in IAW DoD Smallpox Response Plan (Ref. 155) at the time of this writing. It should be understood, however, that persons that are successfully vaccinated will be sufficiently protected from acquiring smallpox, and though Standard and Contact Precautions should still be observed, a respirator (Airborne Precaution) is really not necessary – exceptions to this may be in cases of hemorrhagic smallpox or if the variola strain had been bioengineered to be a "vaccine resistant" variety. It is conceivable that in an emergency situation, there may not be enough immunized Healthcare Workers available to handle the situation. Such situations may thus necessitate vaccinating other Healthcare Workers at the time of emergency and using them even though they have not yet demonstrated full immunity (i.e. have not yet demonstrated a "take"). Vaccination administered within 3-4 days postexposure can prevent disease or severe illness caused by variola virus (Ref. 28). Wearing a minimum of N95 respiratory protection would serve to provide additional protection and in the event that the vaccination did not take. Under this emergency circumstance, it would be a lot less confusing and much easier to enforce respirator use if all healthcare givers had to wear a respirator when entering a room containing an infectious smallpox patient than if some did (those that had not yet demonstrated a clinical take) and some did not (the successfully vaccinated). Note 3: According to the CDC, the weight of the epidemiological evidence suggests that secondary transmission of smallpox occurs when uninfected persons are in <u>close</u> contact with infectious patients, and the concern for airborne transmission over large distances is low. The CDC believes that infectious respiratory droplets, expelled through coughing, sneezing, talking, etc., are more apt to put those near the patient at risk than those at a distance, believing the expelled droplets to normally be too large to travel a far distance in the air, and would more likely tend to settle out over a short distance. Still, airborne transmission does appear to be possible. For instance, Henderson et. al. (1999) reported a case of apparent airborne transmission in Germany, where a smallpox patient with a cough, although isolated in a single room, infected persons on 3 floors of a hospital (Ref. 29). Still, even if airborne spread is possible, other epidemiological evidence would suggest that this is a rare rather than normal event. For example, in India, over 10 years, many sick patients (that were uninfected with smallpox) were only about 20 feet away from smallpox patients, yet the incidence of secondary transmission to these other sick patients was very low.

Table 6-C: Plague

Disease/Etiologic Agent	Infection Control Precautions (Including PPE)
Plague, <i>Yersinia pestis</i> , bacteria	1. Bubonic plague: Standard Precautions (Ref. 45, Ref. 84). 2. Pneumonic plague: Standard Precautions; Droplet Precautions (until the patient has completed 72 hours of antimicrobial therapy) (Ref. 45, Ref. 84). According to the CDC, it is also very important that goggles or a face shield be worn to prevent expelled respiratory droplets (e.g., from coughing, sneezing, etc.) from contacting the eyes. Note 1: neither bubonic nor septicemic plague spreads directly from person to person, though a small percentage (about 12% of total cases in the U.S. over the past 50 years) of patients with bubonic or septicemic plague develop secondary pneumonic plague and can then spread the disease by expelled respiratory droplets (Ref. 35). This process, termed secondary pneumonic plague, develops via spread of plague bacilli from the blood to the lungs (Ref. 35). Primary pneumonic plague resulting from the inhalation of plague bacilli occurs rarely in the U.S. (Ref. 35). Inglesby et. al. (2000) describe 2 recent cases of primary pneumonic plague contracted after 2 people had handled cats with pneumonic plague (Ref. 35). Note 2: Inglesby et. al. (2000) indicate that in large pneumonic plague epidemics in the early 20th century, pneumonic plague transmission was prevented in close contacts by wearing masks (Ref. 35). Commensurate with this, Inglesby et. al. (2000) and the CDC/APIC (1999) believe surgical-type masks (i.e., not true respirators) provide adequate protection against droplet aerosols generated by pneumonic plague patients during coughing, talking, sneezing, etc. (Ref. 35, 45). Note 3: Chernin (1989) indicated that during the Manchurian epidemic (1910-1911) of pneumonic plague, special masks (not respirators, but masks that wrapped around most of the face, covering the nose and mouth) with gowns, goggles, and gloves prevented health care providers from contracting plague (Ref. 32). Note 4: The CDC/APIC (1999) indicates that expelled respiratory droplets are generally larger than 5 µm (Ref. 45). However, such infectious particles could still enter and be deposited in the respiratory tract due to the leakage between the face and surgical mask that occurs (because they are not fitted to the users face) and because the filtration efficiency is highly variable. Meyer (1961) indicated that the entire respiratory tract of man could serve as a portal of entry for plague bacilli in the pestilential air (Ref. 34). Inhalable (see definition in Appendix A) aerosols could deposit anywhere in the respiratory tract. Therefore, one would tend to believe that use of a fitted N95 particulate respirator might be more desirable than a surgical mask. Nonetheless, given the weight of medical opinion appears to be that surgical masks are sufficient, and that primary pneumonic plague resulting from the inhalation of plague bacilli occurs rarely in the U.S., each MTF may make their own determination as to use a surgical mask or a fitted N95 particulate respirator. 3. Airborne precautions should be used with aerosol-generated procedures, such as bone-sawing associated with surgery or postmortem examinations (Ref. 35).

Table 6-D: Other Biological Warfare Agents

Disease/Etiologic Agent	Infection Control Precautions (Including PPE)
Glanders, <i>Burkholderia mallei</i> , bacteria	Standard Precautions. When caring for patients with skin involvement: wear gloves when entering the room, and change gloves after contact with infective material; wear gown when entering room if contact with patient is anticipated or if the patient has diarrhea, a colostomy or wound drainage not covered by a dressing (Ref. 48).
Tularemia, <i>Francisella tularensis</i> , bacteria	Standard Precautions (Ref. 37, 48, 84). Wear gloves when handling clothes soiled with wound or lesion drainage (Ref 43).
Anthrax, <i>Bacillus anthracis</i> spores, bacteria	Standard Precautions for inhalation and cutaneous anthrax (Ref. 45). For cutaneous anthrax, wear gloves when handling clothes soiled with wound or lesion drainage (Ref 43).
Venezuelan Equine Encephalitis (VEE), (<i>Alphavirus</i> genus, VEE species)	Standard Precautions (Ref. 48).
Brucellosis, <i>Brucellae</i> species, bacteria	Standard Precautions (Ref 43, 48.)
Cholera, <i>Vibrio cholerae</i> , bacteria	Standard Precautions (Ref. 48). Also use Contact Precautions for diapered or incontinent children < 6 years of age for duration of illness (Ref. 84).
Q Fever, <i>Coxiella burnetii</i>	Standard Precautions (Ref. 48).
Botulism, <i>Clostridium botulinum</i> neurotoxin	Standard Precautions (Ref. 45).
Staph Enterotoxin B, <i>Staphylococcus aureus</i> toxin	Standard Precautions (Ref. 48)
Ricin, castor plant (<i>Ricinus communis</i>) cytotoxin	Standard Precautions (Ref. 48)
T-2 Mycotoxins	Standard Precautions (Ref. 48)

6.2.2. Clinical/Diagnostic Laboratory.

A. Laboratory methods for BWA identification. Henchal et. al. (2001) present current laboratory methods for biological threat agent identification (Ref. 126).

B. Biosafety procedures when working with etiologic agents within the laboratory. For safe handling of etiologic agents in microbiological and biomedical laboratories, consult the following references:

(1) Biosafety in Microbiological and Biomedical Laboratories, 4th Edition, CDC/NIH: <http://www.cdc.gov/od/ohs/biosfty/bmbl4/bmbl4toc.htm>

(2) Smallpox Response Plan & Guidelines, CDC: <http://www.bt.cdc.gov/DocumentsApp/Smallpox/RPG/index.asp>

6.2.3. Surgery and Post-Mortem Examinations (Autopsies).

A. Post-mortem examinations may be associated with a higher risk, depending on the infectious organism and other factors. It is highly likely that some autopsy procedures will generate aerosols and therefore respiratory protection should be used unless it is absolutely certain it is not necessary (e.g., inhalable aerosols not generated; only splatter, etc., will result). As a general precaution, Airborne, Contact, and Standard Precautions should be used during post-mortem examinations and where surgery requires bone sawing on infectious patients. For instance, common surgical power tools have been shown to create blood-containing aerosols with particles less than 5 µm in diameter (Ref. 109). Particles present in the laser plume generated during laser surgery have been found to have a median aerodynamic equivalent diameter (AED) of about 0.3 µm, with a range of 0.1 to 0.8 µm (Ref. 109).

B. A NIOSH-Certified tight-fitting full-facepiece powered air-purifying respirator (PAPR) equipped with combination high-efficiency particulate air (HEPA) or P-100 filter and organic vapor/acid gas cartridges/canister is recommended for protection against potential inhalable aerosols. A loose-fitting helmet/hooded PAPR may also be used, but only if there is a rigorous program ensuring that batteries are well maintained, they will provide sustained performance during the procedure, and the manufacturer supplies data that demonstrates an assigned protection factor (APF) equivalent to a tight-fitting PAPR. Because use of a PAPR (i.e., rather than a half-facepiece respirator) may increase the chance of injuries with sharps, individuals using PAPRs must be especially careful when handling sharps. Also, because there is a need for sterility during surgery on a live patient, use of a tight-fitting full-facepiece PAPR may not be an option, since the exhaled air from a PAPR is unfiltered and would not be sterile. In this case, a P-100 half-facepiece respirator without an exhalation valve may have to be worn, in conjunction with a face shield or goggles. However, use of a combination NIOSH-Certified loose-fitting helmet/hooded PAPR (to protect the healthcare provider) with a surgical mask (to protect the patient from the healthcare providers germs) is preferred, if possible.

C. If only splatter of body fluids is anticipated, and no aerosols, surgical masks may be used with eye protection or face shields.

D. Follow Standard Precautions (see paragraph 5.2), which would include using gloves and gowns, carefully handling sharps to avoid puncturing or cutting of the skin, and washing hands after gloves are removed.

6.2.4. Secondary Triage. Use of Level C PPE as recommended for Primary Triage personnel is discretionary for Secondary Triage personnel, unless circumstances and monitoring dictate otherwise. Except for the Standard Precaution PPE, no other special PPE is likely necessary, but may depend on the situation. The assumption made herein is that patients have been adequately decontaminated and pose no significant health hazard to secondary triage personnel, they are upwind from the decontamination area, and contaminated clothing is removed and contained upwind.

6.2.5. Decontamination of Patients and Necessary PPE. The need for decontamination depends on the suspected exposure and in most cases will not be necessary (Ref. 45). The following is recommended in addition to Standard Precautions described in paragraph 5.3. See Chapter 5 for further information regarding the selection of PPE. For T-2 mycotoxins, use the same PPE as indicated for CWA and TICs.

A. Covert bioterrorism. In covert bioterrorism, where persons are unknowingly exposed and an outbreak is suspected only upon recognition of unusual disease clusters or symptoms, victims will present for medical care days after an attack – at this point the need for decontamination is minimal or non-existent (Ref. 48). By this time, the victims probably have showered and changed clothes since the time they were exposed and their symptoms appeared.

B. Overt bioterrorism. The following assumes that the “hot zone” of the incident site does NOT involve the hospital facility. A minimum of Level C (with NIOSH-Certified tight-fitting full-facepiece PAPR equipped with HEPA or P-100 filter, rubber gloves, Tyvek or equivalent garments, hood and boot covers, etc.) is preferred. Level C with loose-fitting helmet/hooded PAPRs should only be used if there is a rigorous program ensuring that batteries are well maintained, the batteries will provide sustained performance during the response, and the manufacturer supplies data demonstrating an APF equivalent to a tight-fitting PAPR. A NIOSH-Certified full-facepiece APR equipped with a P-100 filter may also be sufficient, but is less desirable than a PAPR. Barbera et. al. (2001) suggest that hospital decontamination staff will be adequately protected with even less protective respirators, i.e., N95 respirator and that if concern exists for re-aerosolization of agent from patient clothes and skin during the disrobing and shower phase, full face respirators with HEPA or P-100 filter would be sufficient (Ref. 71). Barbera et. al. (2001) suggests that biological terrorism incidents involving biological toxins such as mycotoxins be treated with the same procedures as chemically contaminated patients (Ref. 71).

6.2.6. Primary Triage Personnel. The following only applies to overt attacks, where the concern is with the etiologic agent, and not a patient with a disease caused by a BWA; interaction with patients with a disease caused after a BWA should follow the infection control precautions indicated in Tables 6-A through 6-D.

- Those performing initial triage should wear Level C PPE. Triage personnel should wear rubber gloves, Tyvek or equivalent garments, hood and boot covers, and a minimum of a NIOSH-Certified full-facepiece APR equipped with a Class 100 filter (though a PAPR with HEPA or P100 filters is preferred, if possible). These recommendations are in addition to Standard Precautions described in paragraph 5.3. See Chapter 5 for further information regarding the selection of PPE. For T-2 mycotoxins, use the same PPE as indicated for CWA and TICs.

6.2.7. Perimeter Security (e.g., Security Officers). The following only applies to overt attacks, where the concern is with the etiologic agent, and not a patient with a disease caused by a BWA; interaction with patients with a disease caused after a BWA should follow the infection control precautions indicated in Tables 6-A through 6-D. Also, see Chapter 5 for further information regarding the selection of PPE.

- Perimeter Security should wear Level C PPE, consisting of rubber gloves, Tyvek or equivalent garments, hood and boot covers, and a minimum of a full-facepiece APR equipped with a Class 100 filter (though a PAPR with HEPA or P100 filters is preferred, if possible). These recommendations are in addition to Standard Precautions described in paragraph 5.3. See Chapter 5 for further information regarding the selection of PPE. For T-2 mycotoxins, use the same PPE as indicated for CWA and TICs.

6.3. PPE Guidelines for Handling Patients Before Arrival at the MTF. The following is recommended in addition to standard precautions described in paragraph 5.3. See Chapter 5 for further information regarding the selection of PPE.

6.3.1. Patient Transport to MTF. The following only applies to overt attacks, where the concern is with the etiologic agent, and not a patient with a disease caused by a BWA; transport of patients with a disease caused after a BWA should follow the infection control precautions indicated in Tables 6-A through 6-D. Emergency medical services (EMS) personnel should wear the following PPE while transporting patients in the ambulance:

A. Patients already decontaminated (gross and secondary decontamination) or not requiring decontamination.

(1) The following PPE and other supplies are recommended: disposable gloves, mask/eye protection or face shield, waterproof disposable shoe covers, disposable gowns to cover EMS personnel clothing and to be used by stripped and decontaminated patients, and mouthpiece or other ventilation device as an alternative to mouth-to-mouth resuscitation when practical.

(2) Other minimum supplies include plastic garbage bags, large washbasin or bucket (lined with plastic to isolate toxic vomitus), liquid soap, saline and intravenous tubing for eye irrigation, disposable towels to soak up toxic vomitus, and a large supply of oxygen (Ref. 69c).

B. Contaminated patients that have undergone gross but not secondary decontamination.
The following is recommended:

(1) Personal Protective Equipment:

- NIOSH-Certified tight-fitting full-facepiece APR with P-100 filter, as minimum respirator protection. However, a NIOSH-Certified PAPR (equipped with HEPA or P-100 filter) is preferred, if possible. Loose-fitting helmet/hooded PAPRs may also be used, but only if there is a rigorous program ensuring that batteries are well maintained, they will provide sustained performance during the response, and the manufacturer supplies data demonstrating an APF equivalent to a tight-fitting PAPR.
- Disposable Tyvek or equivalent garments or equivalent with hoods and boot covers
- Polyvinyl chloride (PVC) or duct tape for taping closures
- Rubber boots with steel toes
- Rubber gloves
- Duct tape to seal suit seams, if necessary

***Note:** For T-2 mycotoxins, use the same PPE as indicated for CWA and TICs.

(2) Sufficient 6-mil construction plastic cut to size to:

- Cover floor of ambulance
- Cover squad seat
- Cover litter

(3) Disposable sheet(s)

(4) Plastic trash bags: to contain contaminated medical supply waste, gloves and the victim's clothes, and vomitus

(5) Other: Provide fresh air ventilation to the patients' and drivers' compartments but minimize the re-aerosolization of BWA by carefully handling potentially contaminated items and minimizing drafts.

6.3.2. Incident Site.

A. CDC and OSHA Guidance. At some point (as the science and expert consensus develops), USACHPPM may provide recommendations that consider the factors described in paragraphs 1.2 and 5.4.5.F. Until then, please follow the guidance provided below.

(1) CDC Interim PPE Guidelines for Protection Against BWAs. Appendix E provides the CDC guidelines for interim recommendations for the selection and use of protective clothing and respirators against BWAs at the incident site.

(2) *OSHA's Guidance for Protection Against Anthrax in the Workplace.* Appendix F provides OSHA's guidance for protection against anthrax in the workplace.

B. Transportation HAZMAT Incidents Occurring on Highway or Railroad. The web link for the 2000 ERG is <http://hazmat.dot.gov/guidebook.htm> *Biological agents are categorized under one general category, Guide 158, Infectious Substances.*

SECTION II: PPE SELECTION

CHAPTER 7: CHEMICAL WARFARE AGENT TERRORISM

7.1 General.

7.1.1. Acronyms and terms. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

7.1.2. References. A list of references cited in this Chapter can be found in Appendix B.

7.1.3. Background information. Before reading this Chapter, readers should review Chapter 2 for background information on chemical warfare agent (CWA) terrorism.

7.1.4. Pictures of Personal Protective Equipment (PPE) Levels and Respirators.

A. PPE Levels. On the cover page, there is a picture of a simulated decontamination of a victim at an incident site. Personnel in Level A PPE had delivered a non-ambulatory victim from the exclusion zone to two people performing decontamination in Level B PPE in the decontamination reduction zone. Level C PPE would look similar to Level B PPE except an air-purifying respirator (APR) is worn instead of an atmosphere-supplying respirator, such as the Self-Contained Breathing Apparatus (SCBA) worn by those in this picture.

B. Respirators. Figures 13-A and 13-B provide pictures of APRs and atmosphere-supplying respirators, respectively.

7.1.5. PPE selection. It is essential that readers review Chapter 5 (Introduction and General PPE Selection Information) before reading this Chapter.

7.1.6. Program requirements. Section III provides program requirements for PPE use.

7.2. PPE Guidelines For Handling Patients Arriving at the MTF.

7.2.1. General Care of Patients in the MTF. It is assumed that patients will have been adequately decontaminated before entering the MTF, either at the incident site or outside the MTF, so only Standard Precautions need be applied for care of patients inside the MTF. Other PPE may be necessary outside of the MTF as indicated below.

7.2.2. Secondary Triage. Use of Level C PPE as recommended for Primary Triage personnel is discretionary for Secondary Triage personnel, unless circumstances and monitoring dictate otherwise. Except for the Standard Precaution PPE, no other special PPE is likely necessary, but may depend on the situation. The assumption made herein is that patients have been adequately decontaminated and pose no significant health hazard to secondary triage personnel, they are

upwind from the decontamination area, and contaminated clothing is removed and contained upwind. It may be prudent to procure Level C PPE for secondary triage personnel, to be accessible should circumstance and monitoring indicate it is necessary.

7.2.3. Decontamination of Patients and Necessary PPE. The following assumes that the “hot zone” of the incident site does NOT involve the hospital facility. The following is recommended in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

A. Though Level B may be ideal (in terms of offering the highest level of respiratory protection for the user, etc.), it is possible that it may not be practical, and it is expected that Level C will provide sufficient protection in most (but, perhaps not all) scenarios. Level C with a non-powered full-facepiece APR is the least attractive of the choices, since it provides the least protection of the choices provided in Table 5-B. In consideration of various factors, a minimum of a PAPR is highly recommended for respiratory protection and it is likely that a PAPR may prove to be the best overall procurement choice, offering practicality and a high degree of protection against most materials. Consult Table 5-B and paragraphs 5.2.2.A(7) (pages 48-50) and 5.4.3.(B) (pages 63-64) for further details.

B. The manufacturer’s PPE literature should be reviewed for testing and applicability for protection against CWA.

7.2.4. Primary Triage Personnel. Those performing initial triage should wear a minimum of Level C PPE (Ref. 53a). Triage personnel should wear gloves (consult para. 5.4.3.B, pages 63-64), chemical protective clothing, hood and boot covers, and a minimum of a NIOSH-Certified full-facepiece APR equipped with combination Class 100 filter and organic vapor and acid gas cartridges. However, Level C (with a PAPR, as described in Table 5-B) is preferred for respiratory protection, if possible. The manufacturer’s PPE literature should be reviewed for testing and applicability for protection against CWA. These recommendations are in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

7.2.5. Perimeter Security (e.g., Security Officers).

A. Perimeter security that may come in contact with contaminated patients should wear Level C PPE (Ref. 53a). Perimeter personnel should wear gloves (e.g., butyl rubber gloves over disposable inner nitrile gloves), chemical protective clothing, hood and boot covers, and a minimum of a NIOSH-Certified full-face air-purifying respirator equipped with combination Class 100 filter and organic vapor and acid gas cartridges. However, Level C (with a PAPR, as described in Table 5-B) is preferred for respiratory protection, if possible.

B. The manufacturer’s PPE literature should be reviewed for testing and applicability for protection against chemical warfare agent. For further information regarding selection and use of PPE, see Chapter 5.

7.3. PPE Guidelines for Handling Patients Before Arrival at the MTF.

7.3.1. Patient Transport to MTF. The following is recommended in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

A. Detailed guidance for transporting grossly decontaminated victims is not provided here as is done in Chapter 8 for TICs. The reasoning is that it is critical that the contaminated victims be expeditiously and thoroughly decontaminated to reduce absorption of CWA through the victims skin. Because of the extreme toxicity of CWA and the potential for significant absorption through the skin, a thorough decontamination must be done at the incident site, without delay. A thorough decontamination would also reduce the hazard to personnel transporting the victim, whose contaminated skin or clothing could contaminate personnel by direct contact or off-gassing vapor.

B. The following PPE and other supplies are recommended when patients have been grossly and secondarily decontaminated or do not require decontamination: disposable gloves, surgical mask/eye protection or face shield, waterproof disposable shoe covers, disposable gowns to cover EMS personnel clothing and to be used by stripped and decontaminated patients, and mouthpiece or other ventilation device as an alternative to mouth-to-mouth resuscitation when practical. Other minimum supplies include plastic garbage bags, large washbasin or bucket (lined with plastic to isolate toxic vomitus), liquid soap, saline and intravenous tubing for eye irrigation, disposable towels to soak up toxic vomitus, and a large supply of oxygen (Ref. 69c).

7.3.2. Incident Site. The following is recommended in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

A. Transportation HAZMAT Incidents Occurring on Highway or Railroad. The web link for the 2000 ERG is <http://hazmat.dot.gov/guidebook.htm> *Chemical warfare materials are listed under a general category, Guide 153, Substances – Toxic and/or Corrosive (Combustible).* The following recommendations are made in Guide 153:

- Wear positive-pressure SCBA
- Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection.
- Structural firefighter's protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations.

B. Response to a HAZMAT Incident Involving CWA.

(1) *Hot Zone (or Exclusion Area).* When a chemical is unidentified or is a suspected nerve or blister agent, Level A PPE should be worn during the initial response.

(2) *Decontamination Zone (or Warm Zone)*. If the chemical or concentration is unidentified, personnel in the Decontamination Zone should wear the same protective equipment used in the Hot Zone. A lower level of PPE can be used when the risk of secondary contamination is low or if professional judgment or air monitoring indicates this is safe to do. For example, it may be acceptable to wear a Level B nonencapsulating suit if a Level A encapsulating suit is required in the Hot Zone.

(3) *Support Zone (or Cold Zone)*. Only Standard Precautions need be used when interacting with victims when they have been decontaminated or did not require decontamination.

SECTION II: PPE SELECTION

CHAPTER 8: TOXIC INDUSTRIAL CHEMICAL TERRORISM

8.1. General.

8.1.1. Acronyms and terms. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

8.1.2. References. A list of references cited in this Chapter can be found in Appendix B.

8.1.3. Background information. Before reading this Chapter, readers should review Chapter 3 for background information on toxic industrial chemical (TIC) terrorism.

8.1.4. Pictures of Personal Protective Equipment (PPE) Levels and Respirators.

A. PPE Levels. On the cover page, there is a picture of a simulated decontamination of a victim at an incident site. Personnel in Level A PPE have delivered a non-ambulatory victim from the exclusion zone to two people performing decontamination in Level B PPE in the decontamination reduction zone. Level C PPE would look similar to Level B PPE except an air-purifying respirator (APR) is worn instead of an atmosphere-supplying respirator, such as the Self-Contained Breathing Apparatus (SCBA) worn by those in this picture.

B. Respirators. Figures 13-A and 13-B provide pictures of APRs and atmosphere-supplying respirators, respectively.

8.1.5. PPE selection. It is essential that readers review Chapter 5 (Introduction and General PPE Selection Information) before reading this Chapter.

8.1.6. Program requirements. Section III provides program requirements for PPE use.

8.2. PPE Guidelines For Handling Patients Arriving at the MTF.

8.2.1. General Care of Patients in the MTF. It is assumed that patients will have been adequately decontaminated before entering the MTF, so there are no additional PPE precautions for inside the MTF except Standard Precautions. Other PPE may be necessary outside of the MTF as indicated below.

8.2.2. Victims Exposed Only to Gases or Vapors. The PPE recommended in paragraphs 8.2.4 through 8.2.6 is not necessary if the victims were only exposed to gases or vapors (i.e., no liquid contact with their bodies) and they do not have skin or eye irritation (Ref. 69).

8.2.3. Secondary Triage. Use of Level C PPE as recommended for Primary Triage personnel is discretionary for Secondary Triage personnel, unless circumstances and monitoring dictate otherwise. Except for the Standard Precaution PPE, no other special PPE is likely necessary, but may depend on the situation. The assumption made herein is that patients have been adequately decontaminated and pose no significant health hazard to secondary triage personnel, they are upwind from the decontamination area, and contaminated clothing is removed and contained upwind. It may be prudent to procure Level C PPE for secondary triage personnel, to be accessible should circumstance and monitoring indicate it is necessary.

8.2.4. Decontamination of Patients and Necessary PPE. The following assumes that the “hot zone” of the incident site does NOT involve the hospital facility. The following is recommended in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

A. Though Level B may be ideal (in terms of offering the highest level of respiratory protection for the user, etc.), it is possible that it may not be practical, and it is expected that Level C will provide sufficient protection in most (but perhaps not all) scenarios. Level C with a non-powered full-facepiece APR is the least attractive of the choices provided in Table 5-B, since it provides the least protection of the choices provided. In consideration of various factors, a minimum of a PAPR is highly recommended for respiratory protection and it is likely that a PAPR may prove to be the best overall procurement choice, offering practicality and a high degree of protection against most materials. Consult Table 5-B and paragraphs 5.2.2.A.(7) (pages 48-50) and 5.4.3.(B) (pages 63-64) for further details.

B. The manufacturer’s PPE literature should be reviewed for testing and applicability for protection against TICs.

8.2.5. Primary Triage Personnel. Those performing initial triage should wear a minimum of Level C PPE. Triage personnel should wear gloves (consult para. 5.4.3.B., pages 63-64), chemical protective clothing, hood and boot covers, and a minimum of a NIOSH-Certified full-facepiece APR equipped with combination Class 100 filter and organic vapor and acid gas cartridges. However, a PAPR (as described in Table 5-B) is preferred for respiratory protection, if possible. These recommendations are in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

8.2.6. Perimeter Security (e.g., security officers).

- Perimeter security that may come in contact with contaminated patients should wear Level C PPE. Perimeter personnel should wear gloves (e.g., butyl rubber gloves over disposable inner nitrile gloves), chemical protective clothing, hood and boot covers, and a minimum of a NIOSH-Certified full-facepiece APR equipped with combination Class 100 filter and organic vapor and acid gas cartridges. However, a PAPR (as described in Table 5-B) is preferred for respiratory protection, if possible.

- For further information regarding selection and use of PPE, see Chapter 5.

8.3. PPE Guidelines for Handling Patients Before Arrival at the MTF.

8.3.1. Patient Transport to MTF. The following is recommended in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5. Much of the following was extracted from Reference 69, though some recommendations were modified, changed, or added. The following PPE is recommended while transporting patients in the ambulance.

A. Patients grossly and secondarily decontaminated or those not requiring decontamination. The following PPE and other supplies are recommended: disposable gloves, surgical mask/eye protection or face shield, waterproof disposable shoe covers, disposable gowns to cover EMS personnel clothing and to be used by stripped and decontaminated patients, and mouthpiece or other ventilation device as an alternative to mouth-to-mouth resuscitation when practical. Other minimum supplies include plastic garbage bags, large washbasin or bucket (lined with plastic to isolate toxic vomitus), liquid soap, saline and intravenous tubing for eye irrigation, disposable towels to soak up toxic vomitus, and a large supply of oxygen.

B. Contaminated patients that have undergone gross but not secondary decontamination. The following PPE and other supplies are recommended, however, this only applies to liquid contamination and is not necessary if the victims were only exposed to gases or vapors (i.e., no liquid contact with their bodies) and they do not have skin or eye irritation (Ref. 69)]:

(1) Personal Protective Equipment:

- Minimum of a NIOSH-Certified full-facepiece APR equipped with combination Class 100 filter and organic vapor and acid gas cartridges. However, a PAPR (as described in Table 5-B) is preferred for respiratory protection, if possible.
- Butyl rubber gloves over disposable inner nitrile gloves
- CPC disposable suits with built-in hoods and boot covers
- Polyvinyl chloride (PVC) or duct tape for taping closures
- Two-piece rainwear
- Rubber boots with steel toes
- Duct tape to seal suit seams, if necessary

(2) Sufficient 6-mil construction plastic cut to size to:

- Cover floor of ambulance
- Cover squad seat
- Cover litter

(3) Disposable sheet(s)

(4) Plastic trash bags: to contain contaminated medical supply waste, gloves and the victim's clothes, and vomitus.

(5) *Ventilation*: provide the maximum fresh air ventilation (e.g., open windows) that weather conditions permit to the patient's and driver's compartments, regardless of the presence or absence of odors.

8.3.2. Incident Site. The following is recommended in addition to standard precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

A. Transportation HAZMAT Incidents Occurring on Highway or Railroad. The web link for the 2000 ERG is <http://hazmat.dot.gov/guidebook.htm> *Toxic industrial materials PPE guidelines for various TIC incidents are included.*

B. Response to a HAZMAT Incident Involving TICs. Much of the following was extracted from Reference 69, though some recommendations were modified, changed, or added. There are three concentric areas surrounding a HAZMAT incident:

(1) *Hot Zone (or Exclusion Area).* The hot zone (or Exclusion Area) is the area surrounding the chemical release; it is assumed to pose an immediate health risk to all persons, including rescuers. When a chemical is unidentified, worst-case possibilities concerning toxicity must be assumed and either Level A or B PPE worn, depending on the situation.

(2) *Decontamination Zone (or Warm Zone).* The Decontamination Zone (or Warm Zone) is the area surrounding the Hot Zone where primary contamination is not expected but where personnel must use protective clothing and equipment to avoid chemical exposure from contaminated victims. If the chemical or concentration is unidentified, personnel in the Decontamination Zone should wear the same protective equipment used in the Hot Zone. Generally, the level of PPE is the same as that worn in the Hot Zone or one PPE Level lower than that used in the Hot Zone. A lower level of protective clothing can be used when the risk of secondary contamination is low or if professional judgment or air monitoring indicates this is safe to do. For example, it may be acceptable for a Level B nonencapsulating suit (NFPA splash protective suit) to be used if a Level A encapsulating suit (NFPA vapor-protective suit) is required in the Hot Zone. If the risk of inhaling off-gassing vapors is also low (i.e., the chemical is not highly volatile or the decontamination area is set up outside with good natural ventilation), it may be acceptable to use a lower level of respiratory protection. Air contaminants should be identified and measured to assure safety before a lesser level of respiratory protection is used.

(3) *Support Zone (or Cold Zone).* Only Standard Precautions need be used when interacting with victims when they have been decontaminated or did not require decontamination.

SECTION II: PPE SELECTION

CHAPTER 9: NUCLEAR AND RADIOLOGICAL TERRORISM

9.1. General.

9.1.1. Introduction

A. Acronyms and terms. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

B. References. A list of references cited in this Chapter can be found in Appendix B.

C. Background information. Before reading this Chapter, readers should review Chapter 4 for background information on nuclear and radiological terrorism.

D. Program requirements. Section III provides program requirements for PPE use.

9.1.2. Pictures of Personal Protective Equipment (PPE) Levels and Respirators.

A. PPE Levels. On the cover page, there is a picture of a simulated decontamination of a victim at an incident site. One person in Level A PPE had delivered a non-ambulatory victim from the exclusion zone to two people performing decontamination in Level B PPE in the decontamination reduction zone. Level C PPE would look similar to Level B PPE except an air-purifying respirator (APR) is worn instead of an atmosphere-supplying respirator, such as the Self-Contained Breathing Apparatus (SCBA) worn by those in this picture.

B. Respirators. Figures 13-A and 13-B provide pictures of APRs and atmosphere-supplying respirators, respectively.

9.1.3. PPE selection. It is essential that readers review Chapter 5 (Introduction and General PPE Selection Information) before reading this Chapter.

9.1.4. General Principles.

A. The MTF radiation protection officer (RPO) shall be notified as soon that it is suspected that contaminated casualties will be arriving. Radiation dosimeters should be assigned by the RPO or other appropriate person IAW MTF policy.

B. Ensure that appropriate radiation detectors are available to properly trained personnel.

C. Understand your potential working conditions; for example, number and condition of expected casualties, dust levels, heat stress possibilities. Be alert to health and safety issues.

9.2. PPE Guidelines For Handling Patients Arriving at the MTF.

The MTF RPO shall be notified as soon as it is suspected that contaminated casualties will arrive. Radiation dosimeters should be assigned by the RPO or by other appropriate person IAW MTF policy.

9.2.1. General Care of Patients in the MTF. All patients entering a MTF that are potential victims of radiological/nuclear incident should be considered contaminated unless there is certification or verification of non-contamination. However, the initial management of a casualty possibly contaminated with radiological agents is to perform all immediate life/limb-saving actions without regard to radiological contamination. If patients have been adequately decontaminated before entering the MTF, there are no additional PPE requirements for care of the patient inside the MTF. Standard hospital barrier clothing as used in Standard Precautions is adequate for emergency treatment of limited numbers of radiological contaminated casualties, however, medical personnel should be monitored for contamination and decontaminated if necessary following patients emergency treatment and decontamination.

9.2.2. Secondary Triage. Use of Level C PPE as recommended for Primary Triage personnel is discretionary for Secondary Triage personnel, unless circumstances and monitoring dictate otherwise. Except for the Standard Precaution PPE, no other special PPE is likely necessary, but may depend on the situation. The assumption made herein is that patients have been adequately decontaminated and pose no significant health hazard to secondary triage personnel, they are upwind from the decontamination area, and contaminated clothing is removed and contained upwind.

9.2.3. Decontamination of Patients and Necessary PPE. The following is recommended in addition to standard precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

- Level C (with NIOSH-Certified tight-fitting full-facepiece APR equipped with P-100 filter, rubber gloves; Tyvek or equivalent garments; hood and boot covers, etc.) PPE is acceptable and likely to be adequate for most situations. However, a NIOSH-Certified PAPR (equipped with HEPA or P-100 filter) is preferred for respiratory protection, if possible.

9.2.4. Primary Triage Personnel. Those performing initial triage should wear a minimum of Level C PPE. Triage personnel should wear rubber gloves, Tyvek or equivalent garments, head and boot covers, and a minimum of a full-facepiece APR equipped with a Class 100 filter. However, a NIOSH-Certified PAPR (equipped with HEPA or P-100 filter) is preferred for respiratory protection, if possible. These recommendations are in addition to standard precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

9.2.5. Perimeter Security (e.g., security officers).

- Perimeter security that may come in contact with contaminated patients should wear Level C PPE. Perimeter personnel should wear rubber gloves, Tyvek or equivalent garments, hood and boot covers, and a minimum of a NIOSH-Certified full-facepiece APR equipped with a Class 100 filter. However, a NIOSH-Certified PAPR (equipped with HEPA or P-100 filter) is preferred for respiratory protection, if possible.

- For further information regarding selection and use of PPE, see Chapter 5.

9.3. PPE Guidelines for Handling Patients Before Arrival at the MTF.

9.3.1. Patient Transport to MTF. The following is recommended in addition to Standard Precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5. Emergency medical services (EMS) personnel should wear the following PPE while Transporting Patients in the Ambulance:

A. Patients grossly and secondarily decontaminated or those not requiring decontamination. The following PPE and other supplies are recommended: disposable gloves, surgical mask/eye protection or face shield, waterproof disposable shoe covers, disposable gowns to cover EMS personnel clothing and to be used by stripped and decontaminated patients, and mouthpiece or other ventilation device as an alternative to mouth-to-mouth resuscitation when practical.

B. Patients grossly decontaminated (i.e., outer clothing removed, exposed skin and hair rapidly washed) but not secondarily decontaminated. The following PPE and other items are recommended:

(1) Personal Protective Equipment:

- NIOSH-Certified tight-fitting full-facepiece APR with P-100 filter, as minimum respirator protection. However, a NIOSH-Certified PAPR (equipped with HEPA or P-100 filter) is preferred, if possible. Loose-fitting helmet/hooded PAPRs may also be used, but only if there is a rigorous program ensuring that batteries are well maintained, they will provide sustained performance during the response, and the manufacturer supplies data demonstrating an APF equivalent to a tight-fitting PAPR.
- Tyvek or equivalent garments, hood and boot covers
- Masking tape or duct tape for taping closures and seams
- Rubber boot coverings
- Appropriate safety footwear (shoes with steel toes and/or shanks)
- Surgical gloves, double gloved

(2) Sufficient 6-mil construction plastic cut to size to:

- Cover floor of ambulance
- Cover squad seat
- Cover litter

(3) *Disposable sheet(s)*

(4) *Plastic trash bags:* to contain contaminated medical supply waste, gloves and the victim's clothes, and vomitus.

9.3.2. Incident Site. The following is recommended in addition to standard precautions described in paragraph 5.3. For further information regarding selection and use of PPE, see Chapter 5.

A. Toxic/Hazardous Materials. Consult Chapter 8 if radioactive material is mixed with toxic industrial chemicals (TICs) or if TICs are involved.

B. Nuclear and RDD Incidents.

(1) *Short-duration exposure.* MTF Personnel that may have to retrieve, decontaminate, or treat contaminated patients should wear the following PPE: Level C PPE (*with a tight-fitting full-facepiece APR equipped with combination P-100 filter and organic vapor and acid gas cartridges/canister; gloves; Tyvek or equivalent garments; hood and boot covers*). However, a NIOSH-Certified PAPR (equipped with HEPA or P-100 filter) is preferred for respiratory protection, if possible. It should be noted that a non-powered APR or PAPR may not be used in the situations/atmospheres described in paragraph 5.4.4.A(1), situations/atmospheres that would require the use of an SCBA, otherwise death or serious injury may result.

(2) *Extended-duration exposure.* Personnel that will be at the site for extended periods (days, weeks, or months), such as clean-up crews, etc. will be at greater risk than those exposed for short-durations, and therefore may require a higher level of respiratory protection (to further reduce the dose of inhaled radioactive particulate), such as an SCBA or a tight-fitting powered air-purifying respirator (PAPR) equipped with combination high-efficiency particulate air (HEPA) or P-100 filter and organic vapor and acid gas cartridges/canister.

(3) *Entering buildings on fire.* When entering buildings on fire, structural firefighting gear should be worn – including helmet, SCBA, and turnout gear (thermally insulated coat, pants, and boots). The atmosphere in burning buildings could be oxygen-deficient and have immediately dangerous to life and health (IDLH) concentrations of combustion products (e.g., particularly, carbon monoxide, hydrogen chloride, hydrogen cyanide, acrolein, and carbon dioxide). Air-purifying respirators must not be worn in such atmospheres, or death or irreversible health effects may result. Turnout gear must be worn rather than chemical protective clothing, or thermal injury may result.

(4) *PPE protection from external and internal radiation.* PPE will protect personnel from external alpha particles and all but the most energetic beta particles, but PPE will not protect against external gamma ray or neutron radiation. However, if PPE is properly worn, it

will prevent or reduce the risk of inhalation or inadvertent ingestion of radionuclides and prevent radionuclides from contacting the skin and entering the body.

C. Decontamination. Level C PPE with a tight-fitting full-facepiece air-purifying respirator equipped with combination P-100 filter and organic vapor and acid gas cartridges/canister, gloves, Tyvek or equivalent garments, hood and boot covers should offer adequate protection.

SECTION III: PROGRAM REQUIREMENTS FOR PPE USE

CHAPTER 10: EMERGENCY MANAGEMENT PLANNING

10.1. General.

10.1.1. Acronyms and terms. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

10.1.2. References. A list of references cited in this Chapter can be found in Appendix B. Also, the last paragraph of this Chapter provides additional relevant resources.

10.1.3. Background information. Background information on potential terrorist agents is provided in Section I (Chapters 1-4). Chapter 1 concerns biological warfare agent (BWA) terrorism. Chapter 2 concerns chemical warfare agent (CWA) terrorism. Chapter 3 concerns toxic industrial chemical (TIC) terrorism. Chapter 4 concerns nuclear and radiological terrorism.

10.1.4. Personal protective equipment (PPE) Selection. Selection of PPE is discussed in Section II (Chapters 5-9). Chapter 5 provides an introduction and general PPE selection information for terrorism agents. Chapter 6 provides PPE selection guidance specific to BWA terrorism. Chapter 7 provides PPE selection guidance to CWA terrorism. Chapter 8 provides PPE selection guidance specific to TIC terrorism. Chapter 9 provides PPE selection guidance specific to Nuclear and Radiological terrorism.

10.1.5. Program requirements. Program requirements for PPE use are discussed in this Section, Section III.

10.2. Background.

10.2.1. Protecting health care personnel who respond to emergencies involving hazardous substances is critical. They may be exposed to chemical, biological, physical, or radiological hazards in the process. Hospitals providing emergency response services must be prepared to carry out their missions without jeopardizing the safety and health of their own personnel.

10.2.2. The Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) both have regulations to help protect personnel dealing with hazardous substances and emergency response operations.

A. EPA. Under Title III of the Superfund Amendments and Reauthorization Act of 1986 (also known as SARA), state and local governments must establish a community emergency response plan, which includes the designation of hospitals willing to accept and treat victims from chemical, biological, radiological, nuclear, or explosive (CBRNE) disasters.

B. OSHA. In 1990, OSHA established a comprehensive rule to protect employee health and safety during hazardous waste operations, including emergency responses to the release of hazardous substances.

10.2.3. In December 2000, the U.S. *Army Medical Command (MEDCOM)* published MEDCOM Regulation 525-4, entitled “U.S. Army Medical Command Emergency Response”, which has requirements based on an earlier standard for disaster preparedness published by the Joint Commission for Accreditation of Healthcare Organizations (JCAHO).

10.2.4. In January 2001, the JCAHO introduced new emergency management standards as an update to their long-standing disaster preparedness requirements.

10.2.5. In January 2003, the Department of Defense published Department of Defense Instruction number 2000.18, Department of Defense Installation Chemical, Biological, Radiological, Nuclear and High-Yield Explosive Emergency Response Guidelines, <http://www.dtic.mil/whs/directives/corres/html/200018.htm>

10.3. OSHA Requirements.

10.3.1. In 1990, OSHA established a comprehensive rule to protect employee health and safety during hazardous waste operations, including emergency responses to the release of hazardous substances. This is the *Hazardous Waste Operations and Emergency Response (HAZWOPER)* Standard, Title 29, Code of Federal Regulations (CFR) 1910.120. The HAZWOPER standard requires employers, including hospitals, to plan for emergencies if they expect to use their employees to handle an emergency involving hazardous substances. This includes having a written plan, decontamination equipment, personal protective equipment (PPE) and trained personnel. Emergency response guidance is covered in paragraph “q” of the HAZWOPER rule, which can be viewed in its entirety at the following link: http://www.osha.gov/OshStd_data/1910_0120.html.

10.3.2. Additional emergency planning considerations are contained in OSHA Pamphlet 3152, “*Hospitals and Community Emergency Response – What you Need to Know*”, at the following link: <http://www.osha.gov/Publications/OSHA3152/osha3152.html>. They include:

- Designation of a decontamination team
- Designation of decontamination areas (indoors or outdoors) and procedures
- Description of hospital’s system for immediately accessing info on toxic materials.
- Plan for managing emergency treatment of non-contaminated patients
- Hospital staff use of PPE
- Prevention of cross-contamination of airborne substances via the hospital’s ventilation system
- Air monitoring to ensure facility is safe for occupancy following treatment of contaminated patients

10.4 JCAHO and MEDCOM Requirements.

10.4.1. In January 2001, the Joint Commission for Accreditation of Healthcare Organizations (JCAHO) introduced new emergency management standards as an update to their long-standing disaster preparedness requirements. The environment of care standard now requires MTFs to consider the four phases of emergency management: mitigation, preparedness, response, and recovery. In addition, MTFs must conduct formal hazard vulnerability assessments (HVAs) and develop and implement emergency management plans that ensure effective response to emergencies that impact the environment of care. HVAs and emergency plans should be reviewed periodically and updated as often as necessary. MTFs offering emergency services or designated as disaster receiving stations, must conduct two emergency management drills each year. At least one of the drills must involve an influx of volunteer or simulated patients. These same requirements are also published in MEDCOM Regulation 525-4, U.S. *Army Medical Command Emergency Management*.

10.4.2. The JCAHO defines an emergency as any natural or manmade event that:

- Disrupts the environment of care (such as damage to the hospital due to a tornado, hurricane, or earthquake)
- Disrupts care and treatment of patients (such as a loss of power or other utility)
- Changes or increases demands for the hospital's services (such as a terrorist attack, building collapse, or plane crash in the local community)

10.4.3. The accompanying Draft MEDCOM Pam to MEDCOM Reg 525-4 establishes minimum content requirements for an emergency management plan, which includes at least sixteen different topic areas of concern. The following requirements are relevant to the subject matter covered in this technical guide:

- A. Designing a flexible incident command structure to respond to a variety of emergencies even as they grow in magnitude
- B. Conducting an HVA and implementing specific procedures in response to a variety of disasters (including mass casualties and response to CBRNE events).
- C. Defining, and integrating the organization's role with community-wide emergency management efforts. Integration with the community should include:
 - Sharing essential elements of command structures and critical information, such as names, roles, and telephone numbers of key individuals
 - Developing and using common language and terminology
 - Obtaining and using compatible communication devices
 - Establishing agreements to appropriately distribute casualties among participating healthcare organizations
 - Conducting community-wide emergency management drills
 - Identifying and resources and assets that can be shared among participating healthcare organizations

- Sharing the names of patients and deceased to facilitate identification and location of victims
- D. Locating and setting up facilities for NBC isolation and patient decontamination.
- E. CBRNE special concerns not already addressed in the plan, such as drawing personnel out of the manpower pool and assigning personnel to work outside the scope of their normal duties.
- F. Informing and training personnel who participate in implementing the Emergency Management plan. Training must include:
- An explanation of their specific roles and responsibilities during drills and actual emergencies
 - Specific training designed to provide them with the knowledge and skills necessary to perform their duties during an emergency
 - Availability and use of backup communication systems used during emergencies
 - Availability and procurement of supplies and equipment
- G. Monitoring performance during drills and actual emergencies to identify opportunities for performance improvement.

10.5. Department of Defense Installation CBRNE Emergency Response

Guidelines. Consult the following reference: Department of Defense Instruction number 2000.18, Department of Defense Installation Chemical, Biological, Radiological, Nuclear and High-Yield Explosive Emergency Response Guidelines, 12/04/2003, <http://www.dtic.mil/whs/directives/corres/html/200018.htm>

10.6 Additional Resources.

- Additional information, resources, and links on emergency response can be found on the OSHA website, <http://www.osha.gov/SLTC/emergencyresponse/index.html>
- Disaster Readiness, American Hospital Association, <http://www.aha.org/Emergency/EmIndex.asp>
- Links and Other Contact Information, American Hospital Association, <http://www.aha.org/Emergency/Links/LinksIndex.asp>
- Gardner, Thomas W. PE, (1999). Health Care Facilities Handbook 6th ed. Quincy, Massachusetts: National Fire Protection Association, Inc.
- Strategies for Incident Preparedness: A National Model, National Bioterrorism Civilian Medical Response Center, 2003, <http://www.cimerc.org/projects/Strategies%20for%20Incident%20Preparedness/SIP.pdf>

SECTION III: PROGRAM REQUIREMENTS FOR PPE USE

CHAPTER 11: HAZWOPER TRAINING RECOMMENDATIONS FOR HOSPITAL STAFF

11.1 General.

11.1.1. Acronyms and terms. A glossary of acronyms and terms used in this Chapter can be found in Appendix A.

11.1.2. References. A list of references cited in this Chapter can be found in Appendix B. Also, the last paragraph of this Chapter provides additional relevant resources.

11.1.3. Background information. Background information on potential terrorist agents is provided in Section I (Chapters 1-4). Chapter 1 concerns biological warfare agent terrorism (BWA). Chapter 2 concerns chemical warfare agent (CWA) terrorism. Chapter 3 concerns toxic industrial chemical (TIC) terrorism. Chapter 4 concerns nuclear and radiological terrorism.

11.1.4. Personal protective equipment (PPE) selection. Selection of PPE is discussed in Section II (Chapters 5-9). Chapter 5 provides an introduction and general PPE selection information for terrorism agents. Chapter 6 provides PPE selection guidance specific to BWA terrorism. Chapter 7 provides PPE selection guidance to CWA terrorism. Chapter 8 provides PPE selection guidance specific to TIC terrorism. Chapter 9 provides PPE selection guidance specific to Nuclear and Radiological terrorism.

11.1.5. Program requirements. Program requirements for PPE use are discussed in this Section, Section III.

11.1.6. Overview of the OSHA HAZWOPER regulation and training requirements.

A. The HAZWOPER regulation requires varying levels of training for personnel involved with hazardous material releases, clean-up and emergency response. It is a performance-based regulation that allows employers flexibility in meeting the requirements in the most cost-effective manner. It is not the intent of the regulation to require every person who may become involved in a community emergency response to receive high levels of specialized hazardous materials training. Training should be based on the needs of the community and the potential hazards that could be encountered, under a worst-case scenario. The bottom line is that all individuals must be adequately trained to perform their anticipated duties without endangering themselves or others. Formal training (including refresher training) can be waived for individuals who can physically demonstrate proficiency in all of the required competencies.

B. The OSHA HAZWOPER standard can be viewed at http://www.osha.gov/OshStd_data/1910_0120.html. Please see section “11.6 Additional Resources” of this

technical guide for the appendixes to the standard, as well as links to other sources of information.

11.2 Training Recommendations for Hospital Personnel

11.2.1. As stated above, training under the HAZWOPER regulation is based on the degree of hazard involved, using worst-case scenarios. Each MTF will have to assess their potential hazards, requirements, and resources, and tailor their training program to meet those needs. The sources used to develop the recommendations, herein, include the following references, among others:

- Paragraph (q) of the HAZWOPER regulation (29 CFR 1910.120, Hazardous Waste Operations and Emergency Response)
- OSHA Instruction CPL 2-2.59, (Inspection Procedures for paragraph (q) of the HAZWOPER regulation, 29 CFR 1910.120), 04/24/1998
- OSHA 3152 (Hospitals and Community Emergency Response – What you need to know, 1997)
- HAZWOPER regulation interpretation, 03/10/1999, Emergency response training necessary for hospital physicians/nurses/ that may treat contaminated patients
- Joint Commission Perspectives, Vol. 21, No. 12, Dec. 2001
- Department of Defense Instruction (DoDI) number 2000.18, Department of Defense Installation Chemical, Biological, Radiological, Nuclear and High-Yield Explosive Emergency Response Guidelines, 12/04/2002, <http://www.dtic.mil/whs/directives/corres/html/200018.htm>

11.2.2. Medical staff that will decontaminate victims must be trained to the *First Responder Operations Level*, with additional training on the use of PPE and proper decontamination procedures. Hospitals may develop in-house training or they may send personnel to a standard first responder operations level course, then provide additional training in decontamination and PPE, as needed. The employer must certify that personnel are trained to safely perform their duties, which includes a minimum of eight hours of training (or demonstrated proficiency) and an annual refresher. Personnel also covered under this requirement include those responsible for developing decontamination procedures and selecting PPE for the Decon Team, as well as Emergency Medical Services (EMS) personnel who may have to treat and transport contaminated patients at the disaster site.

11.2.3. Generally, EMS staff that respond to the scene of a CBRN emergency (such as ambulance crews) should have *First Responder Awareness Level* training as a minimum. There is no specific hourly minimum required, but the training must be sufficient to cover the required competencies (or the employees must have proven experience in specific competencies), with an annual refresher. EMS personnel who only receive Awareness Level training should NOT be involved with the transport or treatment of contaminated patients. As stated above, EMS staff that transport or treat contaminated patients must be trained to the Operations Level.

11.2.4. Pre-designated members of the MTF staff that are expected to be involved in the emergency response incident where they might be exposed to a hazardous substance at the MTF

(e.g., receiving, handling, treating, or monitoring contaminated patients, etc.) should receive the following training:

- Be familiar with how the hospital intends to respond to hazardous substance incidents.
- Training in the appropriate use of PPE.
- Participation in scheduled drills.

The pre-designated staff members that are expected to respond and may possibly be exposed to a hazardous substance may include emergency department physicians, emergency department nurses and aids, or other support personnel such as respiratory therapists, security, maintenance personnel, and other ancillary personnel.

11.2.5. Staff, including janitors, security guards, and hospital support personnel, should receive First Responder Awareness level training. Awareness level training for emergency department staff should include an understanding of patient decontamination.

11.2.6. In some unanticipated circumstances, hospital personnel (who are not part of the pre-designated team expected to handle contaminated patients) may be temporarily called in to administer to a contaminated patient. This is not part of their expected duties; however, they may need to perform specialized life-saving treatment (or a specialized support function) that cannot be accomplished by the pre-designated emergency response staff. These are personnel who are not expected to assist in the decontamination of patients, but may be exposed to patients needing immediate life support treatment prior to thorough decontamination. They are considered *Skilled Support Personnel* under paragraph (q)(4) of the HAZWOPER regulation, and do not fall under the other training categories. Instead, they must receive a briefing at the time of the incident which covers the wearing of appropriate PPE, the nature of the CBRNE hazards involved in the emergency, their expected duties, and any other safety and health precautions that they must observe in order to perform their duties safely, including personal decontamination procedures. Other personnel who may have to perform duties in the decontamination area, and qualify as Skilled Support Personnel include but are not limited to custodial/housekeeping staff, logistics staff, laboratory staff, and pastoral care staff.

11.2.7. Ancillary personnel who are expected to clean up the decontamination area, once patient decontamination activities are concluded, must be trained in accordance with paragraph (q)(11) of the HAZWOPER rule, entitled *Post Emergency Response Operations*. This includes training on PPE and respiratory protection, access to material safety data sheets (MSDSs) for the chemicals that may be used to decontaminate equipment and the surrounding area (as well as any other hazard communication concerns), bloodborne pathogens considerations, personal decontamination, and any other applicable safety and health precautions.

11.2.8. A consolidated table of HAZWOPER training recommendations is presented below as Table 11-A.

Table 11-A: HAZWOPER Training Recommendations for Hospital Staff

Staff Category	Training Recommendations
Staff performing patient decontamination	8-hr First Responder Operations Level training, with additional training on PPE and decontamination - Annual refresher - Be familiar with how the hospital intends to respond to hazardous substance incidents - Participation in scheduled drills
Staff who develop the decontamination procedures and select PPE for the workers who help decontaminate patients	8-hour First Responder Operations Level training, with additional training in decontamination procedures
Pre-designated staff that are <u>expected</u> to be involved in the emergency response incident where they might be exposed to a hazardous substance at the MTF (e.g., receiving, handling, treating, or monitoring contaminated patients, etc.). This may include emergency department physicians, nurses and aids, or other support personnel such as respiratory therapists, security, maintenance personnel, and other ancillary personnel.	- Be familiar with how the hospital intends to respond to hazardous substance incidents - Training in the appropriate use of PPE - How to implement basic decontamination procedures - Annual refresher - Participation in scheduled drills
Staff, including janitors, security guards, and hospital support personnel.	First Responder Awareness level training. Awareness level training for emergency department staff should include an understanding of patient decontamination
Staff (who are <u>not</u> part of the pre-designated team expected to handle contaminated patients) who may be temporarily called in to administer to a contaminated patient. This is <u>not</u> part of their expected duties; however, they may need to perform specialized life-saving treatment (or a specialized support function) that cannot be accomplished by the pre-designated emergency staff.	- Considered “Skilled Support Staff” - Requires briefing at time of involvement with emergency response on required PPE, nature of CBRNE hazards that may be encountered, expected duties, and personal decontamination procedures
EMS personnel on-scene, NOT expected to transport or treat contaminated victims; other staff that may go to the site, but will not enter a contaminated environment.	- First Responder Awareness Level training - Annual refresher
EMS personnel on-scene expected to transport or treat contaminated patients; staff on-scene that conduct sampling in contaminated environments.	8-hr First Responder Operations Level training - Annual refresher
Ancillary staff who will be cleaning up the decontamination area at the MTF	Requires training on OSHA Standards for PPE, respiratory protection, HAZCOM, bloodborne pathogens, and personal decontamination

11.3 First Responder Awareness Level Training Requirements

11.3.1. The training requirements for HAZWOPER First Responder Awareness Level are specified in 29 CFR 1910.120 (q)(6)(i). The duration of the training is not specified, but it should be of sufficient content and duration to cover all of the required competencies listed below. Refresher training is required at least annually, or sooner if personnel do not demonstrate proficiency.

11.3.2. Alternatively, personnel who have sufficient experience to objectively demonstrate competency can bypass the classroom training if they can show proficiency in the following areas:

- Understanding of what hazardous materials (HAZMATs) are and their risks
- Understanding of potential outcomes associated with a HAZMAT emergency
- Ability to recognize the presence of a HAZMAT in an emergency
- Ability to identify the HAZMAT, if possible
- Understanding of their role in an Emergency Management Plan response
- Ability to realize need for additional response resources and make appropriate notifications

11.3.3. For other recommended areas of competency, see DoDI number 2000.18, Department of Defense Installation Chemical, Biological, Radiological, Nuclear and High-Yield Explosive Emergency Response Guidelines, 12/04/2002, <http://www.dtic.mil/whs/directives/corres/html/200018.htm>

11.4 First Responder Operations Level Training Requirements

11.4.1. The training requirements for HAZWOPER First Responder Operations Level are specified in 29 CFR 1910.120 (q)(6)(ii). The duration of the training is to be at least eight hours, cover the topic areas listed below, and refresher training is required at least annually, or sooner if personnel do not demonstrate proficiency.

11.4.2. Alternatively, personnel who have sufficient experience to objectively demonstrate competency can bypass the classroom training if they can show proficiency in the following areas:

- All required elements of Awareness Level training, PLUS...
- Knowledge of basic hazard and risk assessment:
 - Hazards associated with hazardous substances
 - Hazard identification
 - Notification procedures
- How to select and use PPE
- Knowledge of basic HAZMAT terms
- How to perform basic control/containment/confinement of HAZMATs
- How to implement basic decontamination procedures

- Be familiar with the local Emergency Management Plan

11.4.3. For other recommended areas of competency, see DoDI number 2000.18, Department of Defense Installation Chemical, Biological, Radiological, Nuclear and High-Yield Explosive Emergency Response Guidelines, 12/04/2002, <http://www.dtic.mil/whs/directives/corres/html/200018.htm>

11.5 HAZWOPER Medical Surveillance Requirements

11.5.1. Members of an organized and designated HAZMAT response team (such as a decon team) shall receive a baseline physical exam and medical surveillance at least annually, or more frequently at the discretion of the physician. The physician may also designate a longer interval, not to exceed two years (biennial).

11.5.2. The medical exam will include medical and work history, a fitness for duty evaluation, and a determination of the employee's ability to wear PPE under conditions that may be expected at the site where the PPE will be used (such as temperature extremes or high altitude). There are additional requirements for personnel who will wear respiratory protection; these are covered in this technical guide under *Section 13.3. Medical Requirements for Respirator Use*. Any personnel involved with an emergency response that exhibits signs or symptoms which may have resulted from exposure to hazardous substances during that emergency shall be provided with a medical consultation as soon as possible.

11.6 Additional Resources

OSHA HAZWOPER Regulation:

- 29 CFR 1910.120: http://www.osha.gov/OshStd_data/1910_0120.html
- Appendix A: PPE Test Methods: http://www.osha.gov/OshStd_data/1910_0120_APP_A.html
- Appendix B: Levels of PPE: http://www.osha.gov/OshStd_data/1910_0120_APP_B.html
- Appendix C: Compliance Guidelines: http://www.osha.gov/OshStd_data/1910_0120_APP_C.html
- Appendix D: References: http://www.osha.gov/OshStd_data/1910_0120_APP_D.html
- Appendix E: Training Curriculum Guide: http://www.osha.gov/OshStd_data/1910_0120_APP_E.html

NIOSH Pocket Guide to Chemical Hazards: <http://www.cdc.gov/niosh/npg/npg.html>

SECTION III: PROGRAM REQUIREMENTS FOR PPE USE

CHAPTER 12: GENERAL REQUIREMENTS FOR A PERSONAL PROTECTIVE EQUIPMENT PROGRAM

12.1 General.

12.1.1. Acronyms and terms. A list of acronyms and terms used in this Chapter can be found in Appendix A.

12.1.2. References. A list of references cited in this Chapter can be found in Appendix B. Also, paragraph 12.1.6 of this Chapter, Chapter 12, provides website links to OSHA's PPE regulatory requirements.

12.1.3. Background information. Background information on potential terrorist agents is provided in Section I (Chapters 1-4). Chapter 1 concerns biological warfare agent (BWA) terrorism. Chapter 2 concerns chemical warfare agent (CWA) terrorism. Chapter 3 concerns toxic industrial chemical (TIC) terrorism. Chapter 4 concerns nuclear and radiological terrorism.

12.1.4. Personal protective equipment (PPE) selection. Selection of PPE is discussed in Section II (Chapters 5-9). Chapter 5 provides an introduction and general PPE selection information for terrorism agents. Chapter 6 provides PPE selection guidance specific to BWA terrorism. Chapter 7 provides PPE selection guidance to CWA terrorism. Chapter 8 provides PPE selection guidance specific to TIC terrorism. Chapter 9 provides PPE selection guidance specific to Nuclear and Radiological terrorism.

12.1.5. Program requirements. Program requirements for PPE use are discussed in this Section, Section III.

12.1.6. Overview of OSHA's PPE regulatory requirements.

A. When occupational hazards are present in the workplace, they should be controlled primarily using engineering methods (such as ventilation systems, physical isolation barriers, etc.). PPE should only be used as a last resort when a hazard cannot be feasibly controlled by a form of engineering control. Personnel who wear PPE must realize that their PPE does not completely remove the hazard; it simply provides a temporary protective barrier between the worker and the hazard.

B. The basic OSHA requirements for a PPE program are covered under 29 CFR 1910.132, http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9777, with specific pieces of protective equipment addressed in subsequent parts of the regulation. The PPE program applies to the use of:

- Eye & face protection (29 CFR 1910.133)
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9778&p_text_version=FALSE
- Respiratory Protection (29 CFR 1910.134)
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12716&p_text_version=FALSE
- Head protection (29 CFR 1910.135)
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9785&p_text_version=FALSE
- Foot Protection (29 CFR 1910.136)
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9786&p_text_version=FALSE
- Hand Protection (29 CFR 1910.138)
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9788&p_text_version=FALSE
- Protective clothing

12.2. Hazard Assessment and PPE Selection.

It is the responsibility of the employer to access the workplace to determine if hazards are present, or are likely to be present that would necessitate the use of PPE. If hazards are present, then the employer must:

- Select the appropriate PPE that will protect their personnel from the hazard
- Communicate that selection decision to the employees
- Ensure that the PPE properly fits the employees
- Ensure that the employees receive training on the care and use of their PPE
- Ensure that the employees actually and properly use the PPE
- Ensure that the employees do not use any damaged or defective PPE

The hazard assessment should be kept in writing, verifying that it was indeed performed.

12.3. Training Requirements.

12.3.1. The employer has to provide training to each employee who is required to use PPE. At a minimum, that training should cover the following:

- When PPE is necessary
- What PPE is necessary
- How to properly don, doff, adjust, and wear PPE
- Limitations of PPE
- Proper care, maintenance, useful life and disposal of PPE

12.3.2. The employees have to demonstrate their understanding of the training by showing they can use the PPE properly before they can use it in the workplace. Refresher training is warranted when the employee cannot demonstrate proficiency in the proper care and use of the PPE, changes in the workplace render the previous training obsolete, or changes in the type of PPE to be used renders the previous training obsolete. The employer also has to maintain a written record of employee training.

SECTION III: PROGRAM REQUIREMENTS FOR PPE USE

CHAPTER 13: RESPIRATORY PROTECTION PROGRAM REQUIREMENTS

13.1. General.

13.1.1. Acronyms and terms. A list of acronyms and terms used in this Chapter can be found in Appendix A.

13.1.2. References. A list of references cited in this Chapter can be found in Appendix B. Also, website links to OSHA's Respiratory Protection Program regulatory requirements are provided throughout this Chapter, Chapter 13. Also, a website link to NIOSH Respirator Topics Page is provided in the last paragraph of this Chapter, Chapter 13.

13.1.3. Background information. Background information on potential terrorist agents is provided in Section I (Chapters 1-4). Chapter 1 concerns biological warfare agent (BWA) terrorism. Chapter 2 concerns chemical warfare agent (CWA) terrorism. Chapter 3 concerns toxic industrial chemical (TIC) terrorism. Chapter 4 concerns nuclear and radiological terrorism.

13.1.4. Personal protective equipment (PPE) selection. Selection of PPE is discussed in Section II (Chapters 5-9). Chapter 5 provides an introduction and general PPE selection information for terrorism agents. Chapter 6 provides PPE selection guidance specific to BWA terrorism. Chapter 7 provides PPE selection guidance to CWA terrorism. Chapter 8 provides PPE selection guidance specific to TIC terrorism. Chapter 9 provides PPE selection guidance specific to Nuclear and Radiological terrorism.

13.1.5. Program requirements. Program requirements for PPE use are discussed in this Section, Section III.

13.1.6. Overview of respirators and OSHA's Respiratory Protection Regulation.

A. A respirator is an enclosure that covers the nose and mouth or the entire face or head, and provides clean, breathable air either from an uncontaminated source (supplied air) or via a filter element that removes the contaminants (air purifying) from the surrounding atmosphere. Respirators come in a wide variety of types and styles; however, like any other form of PPE, they do not remove the existence of an inhalation hazard... they simply protect the wearer from the hazard as long as the integrity of the device is not compromised, and capacity of the device is not exceeded.

WARNING!! An air-purifying respirator does **NOT** supply oxygen, and should never be worn in an oxygen deficient atmosphere!!

B. According to the OSHA Respiratory Protection standard 29 CFR 1910.134, an effective Respiratory Protection Program includes a written program document that, as a minimum, has to address the following elements:

- Procedures for selecting respirators
- Medical evaluations of personnel required to wear respirators
- Procedures for fit testing respirators
- Procedures for the proper use of respirators in routine and emergency situations
- Procedures and schedules for cleaning, disinfecting, inspecting, storing, repairing, discarding, and maintaining respirators.
- Procedures to ensure adequate air quality, quantity, and flow of breathing air for supplied-air respirators.
- Training of personnel on respiratory hazards, proper use of respirators, respirator limitations, and required maintenance
- Identification of filters, cartridges, and canisters
- Procedures for maintaining pertinent records (medical evaluations, fit tests, etc.)
- Procedures to evaluate program effectiveness

The OSHA Respiratory Protection Standard, along with many other respiratory protection technical links, can be viewed at <http://www.osha.gov/SLTC/respiratoryprotection/index.html> .

13.2. Types of Respiratory Protective Devices.

13.2.1. Choosing the correct respiratory protective device depends on several factors. You have to know the chemical and physical properties of the contaminant as well as its concentration and toxicity. You also have to consider whether or not personnel will be working in an oxygen deficient atmosphere, their mobility requirements, environmental conditions, etc. Any commercial respirator must be approved by the National Institute for Occupational Safety and Health (NIOSH) before it can meet OSHA requirements. Consult paragraph 5.4.4 (pages 64-68) for further information.

13.2.2. As stated earlier, respirators are classified under two basic designations: “air purifying” and “supplied air”. An air-purifying respirator (APR) uses sorbents or filters to remove harmful substances from the surrounding air. They are limited in their capability as they cannot be used in oxygen deficient conditions, nor under conditions that are considered immediately dangerous to life or health (IDLH). They are also considered negative pressure devices and are subjected to the limitations of their assigned protection factors. Air purifying respirators are available in several configurations including half facepiece masks, full facepiece devices, and powered air purifying respirators with either a tight fitting facepiece or a loose fitting hood.

Figure 13-A: Air-Purifying Respirators

Disposable Filtering Facepiece APR



Half Facepiece APR



Full Facepiece APR



PAPR with Tight Fitting Facepiece



PAPR with Loose Fitting Hood

13.2.3. Atmosphere supplying respirators are designed to provide breathable air from a clean air source other than the surrounding contaminated work atmosphere. They are usually configured as a self-contained breathing apparatus (SCBA) where the wearer carries the air tank on their back, or as a supplied air respirator (SAR, also known as an airline respirator) where the wearer draws their air from a remote tank via a special hose. Personnel using airline respirators should also have a small escape SCBA with them in the event there is a problem with the airline unit, or they have to quickly exit the contaminated area in an emergency. The air in an atmosphere supplying systems has to be tested to ensure it is at least Grade “D” quality or better (according to the Compressed Gas Association Commodity Specification G-7).

Figure 13-B: Atmosphere-Supplying Respirators

SCBA

Airline Respirator with
Escape SCBA

13.3. Medical Requirements for Respirator Use.

13.3.1. Prior to wearing a respirator, a user needs medical approval to ensure that they are physically, physiologically, and psychologically fit to wear the respirator. For instance, someone not psychologically fit may remove the respirator because they are claustrophobic, etc., and subsequently be exposed to harmful terrorism agents. Someone not physically fit may suffer musculoskeletal damage if the respirator (e.g., Self-Contained Breathing Apparatus) is too heavy for them. Someone not physiologically fit may have a heart attack (if they have heart problems) or experience breathing difficulty (if they have respiratory problems).

13.3.2. A medical evaluation must be performed, by a physician or other licensed health care professional, on any employee who will be required to use a respirator (including disposable filtering facepiece respirators) before that employee is fit tested or required to use the respirator in the workplace. If the employer does not require a respirator but permits the employee to voluntarily wear the respirator, anyway, medical approval is not required for filtering facepiece respirators but IS required for elastomeric facepieces. The physician may use the OSHA medical questionnaire contained in Appendix C of the OSHA standard (http://www.osha.gov/OshStd_data/1910_0134_APP_C.html), or perform a physical examination that obtains the same information as required in the questionnaire.

13.3.3. Once an employee has been medically evaluated, the physician will issue a written recommendation regarding the employee's ability to use respiratory protection. This written recommendation will include any limitations on respirator use related to the medical condition of the employee, the workplace conditions under which the respirator will be used, and whether or not the employee can safely wear a respirator. It will also address any required follow-up medical evaluations. If an employee is supposed to use a negative pressure respirator, and the physician finds a medical condition that could place the wearer at increased health risk if they use that respirator, then a PAPR will be used instead (provided the employee can wear such a device safely).

13.3.4. The OSHA respiratory protection standard does not require an annual or otherwise periodic medical re-evaluation. However, a medical re-evaluation is required when:

- An employee reports signs or symptoms related to their ability to wear a respirator
- The physician or supervisor determines it is necessary
- Information from the respiratory protection program (such as observations made during fit testing or a program evaluation) indicates a need for re-evaluation
- A change occurs in workplace conditions that may result in a substantial increase in the physiological burden placed on the employee

13.4. Fit Testing of Respirators.

13.4.1. Prior to wearing a tight-fitting respirator, the user must be fit-tested by a qualified person to ensure the respirator fits properly to the users face. Otherwise, harmful materials may leak in high amounts through the spaces between the respirator facepiece seal and the users face, and the user may subsequently breathe in harmful levels of these materials.

13.4.2. Even though there are many different brands and types of respirators on the market, they all have different fit characteristics. There is not a single tight fitting respirator that will fit everyone. Consequently, employers have to have sufficient sizes and models available for employees to try on during fit testing. All respirators with tight fitting facepieces (including disposable filtering facepiece respirators) have to be fit tested if they are required to be worn in the workplace... even positive pressure devices (they are fit tested in a negative pressure mode). In addition, these respirators must be fit tested before they can be worn in the workplace. If the employer does not require a respirator but permits the employee to voluntarily wear the respirator, anyway, fit testing is NOT required.

13.4.3. It is important to reiterate that a tight fitting respirator is only as good as the face-to-facepiece seal achieved by the wearer. Many things can interfere with that seal, including facial hair, eyeglasses, facial scars, facial jewelry, and severe dental problems. Personnel wearing tight fitting respirators cannot wear any facial hair, jewelry, or headgear that will interfere with the seal. For personnel who require corrective eyewear, special mountings are available for full facepiece respirators that hold corrective lenses inside the mask. OSHA does allow the use of contact lenses with respirators.

13.4.4. The effectiveness of the fit of the facepiece can be tested two ways: qualitatively and quantitatively. A qualitative fit test involves the introduction of a harmless but odoriferous or irritating substance into the breathing zone around the respirator while it is being worn. For APRs, the proper cartridges must be used that will remove the test agent. If the wearer detects no odor or irritation, a proper fit is achieved. A quantitative fit test uses an electronic device that measures ambient particulates in the air both outside and inside the facepiece (via a special probe) while the wearer performs a series of exercises. These particulate levels are then compared to see how much particulate is leaking into the mask. Another quantitative device uses controlled negative pressure measurements to determine if the facepiece is leaking or not.

Figure 13-C: Qualitative and Quantitative Fit TestingQualitative Fit Testing
Using Irritant SmokeQuantitative Fit Testing using an Ambient
Particulate Measuring Device

13.4.5. All personnel must be fit-tested with their own respirator (or one that is the same make, model, size, and style) before they can use it in the workplace. Positive pressure devices (SCBAs, airlines, PAPRs) that have tight fitting facepieces have to be tested in a negative pressure mode using the same model and size of facepiece. Fit testing can be done using any OSHA-approved qualitative or quantitative method (depending on required protection factor) listed in 29 CFR 1910.134 Appendix A (http://www.osha.gov/OshStd_data/1910_0134_APP_A.html). Fit-testing must be conducted at least annually, or sooner when there is a change in the respirator used or there are medical considerations that effect respirator fit (such as a significant weight change, facial scarring, dental changes, or cosmetic surgery). Personnel who wear respirators must also conduct a user seal check (positive and negative pressure) each time they don their respirator (see Appendix B-1 of the OSHA respirator standard at http://www.osha.gov/OshStd_data/1910_0134_APP_B_1.html).

13.5. Training Requirements for Respirator Use.

13.5.1. Anyone who is required to wear a respirator has to be trained in the proper use and limitations of that device prior to its use in the workplace. The training has to be comprehensive enough so that when it is completed, the employee will be able to demonstrate a knowledge of the capabilities and limitations of the respirator, why it is necessary, and how improper fit, usage, or maintenance can compromise the respirator, causing a potential overexposure to air contaminants. Refresher training is required at least annually, or sooner if changes in the workplace or type of respirator renders previous training obsolete, the employee does not demonstrate proficiency in the proper care and use of their respirator, or any other situation arises where retraining appears necessary to ensure safe respirator use.

13.5.2. At a minimum, the training has to cover the following topic areas:

- The nature of the respiratory hazard, and why a respirator is needed
- Respirator capabilities, limitations, and consequences if the respirator is not used correctly
- How to handle respirator malfunctions and other emergencies

- How to inspect, don, doff, use, and check seals on the respirator
- Maintenance and storage procedures
- When to change cartridges on air purifying respirators
- How to recognize medical signs and symptoms that may limit or prevent effective use of a respirator
- General requirements of the respiratory protection program

13.6. Additional Resources.

NIOSH Respirator Topics Page: <http://www.cdc.gov/niosh/respinfo.html>

This page includes links to:

- The NIOSH Respirator Decision Logic
- The NIOSH Certified Equipment List (a listing of all respirators certified by NIOSH)
- NIOSH Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR 84
- NIOSH Pocket Guide to Chemical Hazards
- And much more!...

SECTION III: PROGRAM REQUIREMENTS FOR PPE USE

CHAPTER 14: BLOODBORNE PATHOGEN PROGRAM REQUIREMENTS

14.1 General

14.1.1. Acronyms and terms. A list of acronyms and terms used in this Chapter can be found in Appendix A.

14.1.2. References. A list of references cited in this Chapter can be found in Appendix B. A website link to OSHA's bloodborne pathogens regulation is provided in paragraph 14.1.6 of this Chapter, Chapter 14. Also, a website links to other relevant information is provided in the last paragraph of this Chapter, Chapter 14.

14.1.3. Background information. Background information on potential terrorist agents is provided in Section I (Chapters 1-4). Chapter 1 concerns biological warfare agent (BWA) terrorism. Chapter 2 concerns chemical warfare agent (CWA) terrorism. Chapter 3 concerns toxic industrial chemical (TIC) terrorism. Chapter 4 concerns nuclear and radiological terrorism.

14.1.4. Personal protective equipment (PPE) selection. Selection of PPE is discussed in Section II (Chapters 5-9). Chapter 5 provides an introduction and general PPE selection information for terrorism agents. Chapter 6 provides PPE selection guidance specific to BWA terrorism. Chapter 7 provides PPE selection guidance to CWA terrorism. Chapter 8 provides PPE selection guidance specific to TIC terrorism. Chapter 9 provides PPE selection guidance specific to Nuclear and Radiological terrorism.

14.1.5. Program requirements. Program requirements for PPE use are discussed in this Section, Section III.

14.1.6. Overview of the OSHA bloodborne pathogens regulation.

A. The OSHA bloodborne pathogens regulation (29 CFR 1910.1030) applies to every employer with one or more employees who can reasonably be expected to come into contact with blood or other potentially infectious body fluids while performing their duties. However, this group also includes law enforcement personnel, EMTs, firefighters, paramedics, and anyone else who may provide first-response medical care in which there is a reasonable expectation of contact with blood or other potentially infectious materials. The full standard can be viewed at http://www.osha.gov/OshStd_data/1910_1030.html.

B. Under the OSHA rule, "blood" means human blood, blood products, or blood components. Other potentially infectious materials include human body fluids such as saliva (in dental procedures); semen; vaginal secretions; cerebrospinal, synovial, pleural, pericardial, peritoneal, and amniotic fluids; any body fluids visibly contaminated with blood; unfixed human tissues or organs; cell or tissue cultures containing human immunodeficiency virus (HIV) or

hepatitis-B virus (HBV); and all body fluids in situations where it is difficult or impossible to differentiate between body fluids.

C. Hospitals must develop a written Exposure Control Plan, and review/update it at least annually or whenever new tasks and procedures affect occupational exposure. The plan has to identify and document the tasks, procedures, and job classifications covering instances where there is exposure to blood or other potentially infectious materials. It also has to cover a schedule of how and when provisions of the standard will be implemented, including schedules and methods for communicating hazards to employees; HBV vaccination, post-exposure evaluation, and follow-up; record keeping; engineering and work practice controls; PPE; housekeeping; and procedures for evaluating the circumstances surrounding an exposure incident. A recent update to the OSHA standard now requires employers to document the consideration and use of appropriate, commercially available, safer medical devices to help prevent needle sticks and other sharps injuries.

14.2 Training Requirements

All persons with a potential for exposure to bloodborne pathogens must be provided with adequate training and information on the employer's bloodborne pathogens control program at the time of their initial assignment to tasks where occupational exposure to bloodborne pathogens may occur. Refresher training is required at least annually, or sooner if existing tasks are modified or new tasks are required which affect the employees' occupational exposure potential. At a minimum, the training has to cover the following topics:

- How to obtain a copy of the OSHA regulation, and explanation of its text
- Information on the epidemiology and symptoms of bloodborne diseases
- Explanation on ways in which bloodborne pathogens are transmitted
- Explanation of the employer's Exposure Control Plan, and how to get a copy of it
- Information on how to recognize tasks that might result in an occupational exposure
- Explanation of the use and limitations of work practices, engineering controls and PPE
- Information on types, selection, proper use, location, removal, handling, decon and disposal of PPE
- Information on Hepatitis B vaccination
- Information on who to contact and what to do in an emergency
- Information on how to report an exposure incident, as well as post-exposure evaluation and follow-up procedures
- Information on warning labels, signs, & color coding used in the facility (as applicable)

14.3 Recommended PPE for Universal Precautions Use

14.3.1. The term "universal precautions" pertains to a method of infection control in which all human blood and certain body fluids are treated as if they are known to be infectious for HIV, HBV, and other bloodborne pathogens. Universal precautions are to be observed in all situations

where there is potential for contact with blood or other potentially infectious material. Part of the universal precautions method is the use of appropriate PPE.

14.3.2. Personal protective clothing and equipment is only considered “appropriate” if it does not permit blood or other potentially infectious materials to pass through to or reach the employee’s work clothes, street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions and duration of use. Hypoallergenic alternatives (such as non-latex or powderless gloves) must be available to employees who have an allergic sensitivity to the PPE normally used in the facility. Under universal precautions, PPE consists of (but is not limited to):

- Gowns
- Gloves (disposable or re-usable)
- Lab coats
- Face shields
- Eye protection (goggles, glasses, etc)
- Masks
- Shoe covers
- Head covers
- Mouthpieces, resuscitation bags, pocket masks or other ventilation devices

14.3.3. Employers must ensure that the proper PPE is used correctly, and that it is properly cleaned, laundered, repaired, replaced, or disposed of as needed, at no cost to the employee. Employees must ensure they remove and replace any garments penetrated by blood or other infectious materials immediately or as soon as feasible. Likewise, gloves must be replaced if they are torn, punctured, or otherwise rendered ineffective as a barrier for blood or other fluids.

14.4 Additional Resources

Additional information can be found at the following websites:

General bloodborne pathogens: <http://www.osha.gov/SLTC/bloodbornepathogens/index.html>

Needlestick injury prevention: <http://www.osha.gov/SLTC/needlestick/index.html>

APPENDIX A

GLOSSARY OF TERMS AND ACRONYMS

Section I: Acronyms

AED	Aerodynamic equivalent diameter
ACGIH	American Conference of Governmental Industrial Hygienists
AFRRI	Armed Forces Radiobiology Research Institute
AIHA	American Industrial Hygiene Association
AMEDD	Army Medical Department
ANSI	American National Standards Institute
APF	Assigned protection factor
APR	Air purifying respirator
AR	Army regulation
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BWA	Biological warfare agent
CASHPAC	Chemical Agent Safety and Health Policy Action Committee
CBRN	Chemical, biological, radiological, nuclear
CBRNE	Chemical, biological, radiological, nuclear, and explosive
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
cm	Centimeter (one-hundredth of a meter)
cGy	10 ⁻² Gray (Gy)
CPC	Chemical protective clothing
CWA	Chemical warfare agent
Decon	Decontamination
DIC	Disseminated intravascular coagulation
DNA	Deoxyribonucleic acid
DoD	Department of Defense
DoDI	Department of Defense Instruction
DOP	Diethylphthalate
ED ₅₀	Median effective dose
EMS	Emergency medical services
EMT	Emergency medical technician
EPA	Environmental Protection Agency
ERG	Emergency Response Guidebook
ERPG	Emergency Response Planning Guideline
ESLI	End-of-service-life indicator

FEMA	Federal Emergency Management Agency
g/cm^3	grams per cubic centimeter
HAZMAT	Hazardous materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBV	Hepatitis-B virus
HEPA	High efficiency particulate air (filter)
HF	Hemorrhagic fever
HFRS	Hemorrhagic fever with renal syndrome
HIV	Human immunodeficiency virus
HVA	Hazard vulnerability assessment
HVAC	Heating, ventilation, and air-conditioning
IAB	InterAgency Board
IAW	In accordance with
ICRP	International Council on Radiation Protection and Measurement
IDLH	Immediately dangerous to life or health
ID ₅₀	Median Infective Dose
ID ₅₀	Median “Incapacitation” Dose
IND	Investigational new drug
IOM	Institute of Medicine
JCAHO	Joint Commission for Accreditation of Healthcare Organizations
J/kg, J kg ⁻¹	Joule per kilogram
Kt	Kiloton
LC ₅₀	Median Lethal Concentration over a period of time
LCt ₅₀	Median Lethal Concentration multiplied by exposure time
LD ₅₀	Median lethal dose
LET	Linear energy transfer
MEDCOM	U.S. Army Medical Command
mg/m ³	milligrams per cubic meter
μg/kg	micrograms per kilogram
μm	micrometer (a millionth of a meter)
mm	millimeter (a thousandth of a meter)
MSDS	Material safety data sheet
MTF	Medical treatment facility
MUC	Maximum use concentration
MW	Molecular weight
NAERG	North American Emergency Response Guidebook
NBC	Nuclear, Biological, Chemical
NCRP	National Council on Radiation Protection and Measurement

NFPA	National Fire Protection Association
NIH	National Institute of Health
NIJ	National Institute of Justice
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PAPR	Powered air-purifying respirator
PEL	Permissible exposure limit
pfu	plaque forming units
pg	picograms
PPE	Personal protective equipment
ppm	parts per million
PVC	Polyvinyl chloride
RDD	Radiation dispersal device (i.e., “dirty bomb”),
RNA	Ribonucleic acid
RPO	Radiation protection officer
SAR	Supplied air respirator
SARA	Superfund Amendments and Reauthorization Act
SBCCOM	Soldier and Biological Chemical Command
SCBA	Self contained breathing apparatus
SEB	Staphylococcal Enterotoxin B
SEI	Safety Equipment Institute
TB	Tuberculosis
TG	Technical guide
TIC	Toxic industrial chemical
TIM	Toxic industrial material
TLV	Threshold limit value
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAMRICD	U.S. Army Medical Research Institute of Chemical Defense
USAMRIID	U.S. Army Medical Research Institute of Infectious Diseases
VHA	Veterans Health Administration
VHF	Viral hemorrhagic fevers
WEEL	Workplace environmental exposure level
WMD	Weapons of mass destruction

Section II: Terms

Absorbed dose

The energy imparted by ionizing radiation per unit of mass of irradiated material (Ref. 57). The units of absorbed dose are the rad and the gray (Gy) (Ref. 57).

Active immunization

The act of artificially stimulating the body to develop antibodies against infectious disease by the administration of vaccines or toxoids (Ref. 48).

Acute effects

Adverse effects arising soon after a short exposure (minutes to hours) to “high” concentrations of a chemical. For example, short exposure to high concentrations of some airborne chemicals may cause acute effects such as sensory irritation (eye, nose, and throat irritation), difficulty breathing, dizziness, lightheadedness, stupor, sleepiness, or more serious conditions such as unconsciousness, coma, pulmonary edema, etc., and even death if the dose is high enough. The intoxicating effects experienced from drinking alcohol would be considered an acute effect, as would be nose, eye, and throat irritation caused by cigarette smoke.

Acute exposure

Single or multiple exposure(s) to a substance for less than 24 hours (Ref. 79).

Adhesion forces

1. Intermolecular forces keeping two different solid or liquid materials adhered together. The main forces include the van der Waals force (an attractive force between molecules, effective up to a few molecular diameters away), the electrostatic force (most particles 0.1 μm or larger carry some small net charge), and the force arising from the surface tension of adsorbed liquid forms – under normal conditions, most materials have adsorbed liquid molecules on their surface, and an attractive force between a particle and a surface is created by the surface tension of the liquid drawn into the capillary space at the point of contact (Ref. 92). All of these forces are affected by the material, shape, surface roughness, and size of the particle; the material, roughness, and contamination of the surface; relative humidity; temperature; the duration of contact; and the initial contact velocity (Ref. 92).

2. Aerosol particles may adhere to surfaces they contact or may form larger agglomerates when they contact each other (Ref. 92). The adhesive forces on micrometer-size particles exceed other common forces by orders of magnitude (Ref. 92). As the particle size decreases, it becomes more difficult to remove particles from surfaces (Ref. 92). For instance, everyone has probably experienced the relative difficulty of reaerosolizing or removing from surfaces at least one of the following settled submicrometer (physical diameters $< 1 \mu\text{m}$) particles: tobacco smoke, oil smoke, rosin smoke, carbon black (Ref. 129). Compare this to the relative ease of reaerosolizing

or removing from surfaces one of the following settled supermicrometer (physical diameters $> 1 \mu\text{m}$) particles: insecticide dusts (0.5-10 μm), ground talc (0.5-50 μm), milled flour (1-80 μm), coal dust (1-100 μm), fly ash (1-200 μm) cement dust (3-100 μm), plant spores (10-30 μm), pollen (10-100 μm), general road or house dust (3-300 μm , normally, but up to 1 cm), ground limestone fertilizer (10 μm – 1 mm), fine sand (20-200 μm), course sand (200 μm – 2 mm), and beach sand (90 μm – 2 mm) (Ref. 129).

3. According to Hinds (1999), while individual particles less than 10 μm are not likely to be removed from surfaces by common forces, a thick layer of such particles may be easily dislodged in large (100 μm to 10 mm) chunks when blown or shaken from the surface (Ref. 92). It should not be construed from the previous sentence that particles less than 10 μm can not be reaerosolized by common forces, since we now know this is not necessarily the case if the biological agent is weaponized. For example, we now know that settled weaponized Anthrax spores (about 1 μm in physical diameter) can be reaerosolized, as individual spores, as spore agglomerates, or when adhered to other particles (e.g., dust), particle sizes that, when inhaled, can penetrate and deposit into the thoracic and respirable regions of the respiratory tract (Ref. 157). Anthrax spores may be weaponized by reducing the electrostatic charge in a fashion that makes them less able to stick together and therefore have less potential to agglomerate and make larger particles.

4. There is one statement that can be said with relative certainty with regard to settled particulates, and that is, if reaerosolized, the aerosolized particle distribution will tend to have relatively larger-sized particles and relatively fewer smaller-sized particles than in the originally dispersed aerosol.

Adverse effect

A biochemical change, functional impairment, or pathological lesion that impairs performance and reduces the ability of the organism to respond to additional challenges (Ref. 91).

Aerodynamic equivalent diameter

The aerodynamic equivalent diameter (AED) describes the *behavior* of an airborne particle and is dependent upon the particle density, shape, and size (Ref.88). The particle AED is defined as the diameter of a smooth, unit density [$\rho_0 = 1$ gram per cubic centimeter (g/cm^3)] sphere that has the same terminal settling velocity as the actual particle (Ref. 88). That is, considering an airborne particle of a certain density, shape, and size, what physical diameter would it have to be (and still have the same terminal settling velocity as the actual particle) if it were instead a smooth round sphere with a density of 1 g/cm^3 . The AED therefore describes the behavior of an airborne particle and is not the same as the physical diameter (which can be measured directly by a microscope) of a particle. The AED can be determined indirectly through sampling with various types of samplers (e.g., cascade impactors). For particle AEDs diameters greater than about 0.5 μm , the significant mechanisms for the settling rate of suspended particles and their penetration into the respiratory tract is in accordance with the particle AED, an expression that accounts for the inertial and aerodynamic drag properties of particles. The smaller the AED of the suspended particle, the longer it may remain suspended in the air. After particles greater than about 0.5 μm AED are inhaled, they deposit within the respiratory system by sedimentation or impaction according to their AED (Ref. 92). After particles with diffusive or physical diameters

less than about 0.5 μm are inhaled, they deposit within the respiratory system predominately by diffusion unless the particles are hygroscopic (as are microorganisms) and increase to a physical diameter greater than 0.5 μm , where the deposition mechanism would then be by impaction or sedimentation.

Aerosol

A suspension of solid or liquid particles in a gas (Ref. 92). Aerosols are usually stable for at least a few seconds and some cases may last a year or more (Ref. 92). The term aerosol includes both the particles and the suspending gas, which is usually air (Ref. 92). Particle size ranges are from about 0.002 μm to more than 100 μm (Ref. 92).

Agglomerate - A group of particles held together by van der Waals forces or surface tension.

Air-purifying respirator

A respirator with an air purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element. For protection against chemical gasses and vapors, the respirator must be equipped with an ESLI certified by NIOSH for the contaminant. If there is no ESLI, the canisters or cartridges must be changed before the end of their service life (based upon objective information or data). An air-purifying respirator cannot be used if any of the following situations apply:

- Atmospheres contain chemical concentrations that are IDLH.
- Atmospheres are oxygen-deficient.
- Filter, cartridge, or canister does not effectively remove the chemical.
- Airborne concentrations exceed the MUC for the respirator.
- Firefighting.
- First response to accidents or terrorist incidents where chemical concentrations are unknown or suspected of being higher than what an APR would provide sufficient protection against.

Airborne droplet nuclei

Small ($< 6 \mu\text{m}$) particles of respiratory secretions that are aerosolized by coughing, sneezing, talking, or singing (Ref. 87), and for which special precautions are necessary when patients are known or suspected to be infected with microorganisms transmitted by airborne droplet nuclei. As droplets are forcefully expelled from the respiratory tract they evaporate and thus change in respect to their mass and aerodynamic diameter (Ref. 87). For instance, a sneeze can generate as many as 40,000 droplets, which can evaporate to particles in the 0.5-12 μm range (Ref. 87). The smaller the aerodynamic equivalent diameter of the suspended particle, the longer it may remain suspended in the air, some retaining and some losing infectivity or virulence. Upon complete evaporation, the particles may be small enough to remain airborne for a long time (Ref. 87). Also, microorganisms are hygroscopic (absorb moisture readily), and so the relative humidity of

an indoor environment can have a dramatic effect on the particle's aerodynamic diameter, length of time airborne, and viability (Ref. 87). Viability is important, since only viable microorganisms can initiate an infectious process (Ref. 87). When the microorganisms or airborne droplet nuclei are inhaled, they will increase in size as they absorb moisture as they move through the humid respiratory tract (Ref. 87). Particles that settle out (including droplets larger than droplet nuclei) from the air and onto surfaces, can potentially be reentrained back into the indoor air following decreased size due to droplet evaporation, in combination with an aerosol generating activity such as making the bed (Ref. 87).

Airborne particle diffusion

Particles with a diffusive or physical diameter less than 0.5 μm will remain airborne for a long period of time, and are easily transported in the air and are able to readily penetrate into the deep lung. As the physical size of an airborne particle decreases, it becomes more susceptible to random displacements (diffusion) caused by collisions with gas molecules that are in Brownian motion. The smaller the airborne particle, the more it is affected by collisions with gas molecules. After particles with physical diameters less than about 0.5 μm are inhaled, they deposit within the respiratory system more so by diffusion mechanisms (rather than sedimentation or impaction), unless the particles are hygroscopic (as are microorganisms) and increase to a physical diameter greater than 0.5 μm , where the deposition mechanism would then be by impaction or sedimentation.

Airborne Precautions

Special precautions used for patients known or suspected to be infected with microorganisms transmitted by airborne droplet nuclei (small particle residue, 5 μm or smaller in size) of evaporated droplets containing microorganisms that remain suspended in the air and that can be dispersed widely by air currents within a room or over a long distance) (Ref. 45). Special precautions include (Ref. 48):

- Special ventilation for the room the patient is placed in, such as monitored negative air pressure in relation to the corridor and surrounding areas; 6-12 air changes per hour; appropriate discharge of air outdoors, or monitored high efficiency filtration of air; and a door that must remain closed (Ref. 45).
- Placing the patient in a private room (preferred) (Ref. 45). However, in the event of a large outbreak, patients who have active infections with the same disease (e.g., smallpox), may be cohorted in rooms that meet appropriate ventilation and airflow precautions for Airborne Precautions (Ref. 45).
- Requiring respiratory protection to be worn by healthcare providers and others when entering the patient room (Ref. 45).
- Limiting the movement and transport of the patient from the room to essential purposes only. If transport or movement is necessary, patient minimize patient dispersal of droplet nuclei by placing a surgical mask on the patient, if possible (Ref. 84).

Conventional Diseases requiring Airborne Precautions (Ref. 48): Measles, Varicella, Pulmonary Tuberculosis.

Biothreat Diseases requiring Airborne Precautions: Smallpox (Ref. 45); Viral Hemorrhagic Fevers (Ref. 100); Plague, but ONLY during procedures that may generate aerosols during post-mortem examinations or surgery, such as bone-sawing per Inglesby et. al. (2000) (Ref. 35) - please note, however, that the CDC does not believe that airborne precautions are even necessary under these circumstances.

Amniotic fluid

The body fluid surrounding a developing fetus.

Antibody

Any of the complex glycoproteins produced by B lymphocytes in response to the presence of an antigen (Ref. 79). Antibodies, all of which are immunoglobulins, may combine with specific antigens to destroy or control them, providing protection against most common infections (Ref. 79). Almost all antibodies except natural antibodies (e.g., antibodies to different blood types) are created by B cells linking with a foreign antigen on the surface of an invading organism (Ref. 79).

Antigen

A protein or oligosaccharide marker on the surface of cells that identifies the cell as self or non-self (Ref. 79).

Antitoxin

An antibody formed in response to an capable of neutralizing a biological poison; an animal serum containing antitoxins (Ref. 48).

Aplastic anemia

Anemia caused by deficient red blood cell production due to bone marrow disorders (Ref. 79).

Apnea

Temporary cessation of breathing (Ref. 79).

Assigned protection factor

The minimum expected workplace level of respirator protection that would be provided by a properly function respirator or a class of respirators to properly trained and fitted users. For example, an APF of 50 for a tight-fitting full facepiece air-purifying respirator would mean that the air contaminant concentrations breathed inside the respirator would not be expected to be any higher than 1/50th of the air contaminant concentrations outside the respirator, as long as the respirator is working properly, the respirator filters or cartridges/canister are selected and used correctly, the user has been properly fit-tested by a qualified person, and the user has successfully fit-checked their respirator immediately before entering the environment containing the contaminated atmosphere. Assigned protection factors are typically derived from either the 95th percentile or worst-case result from field or laboratory measurements of respirators. Under certain circumstances, an arbitrary “safety factor” (e.g., factor of 10) is applied to laboratory fit-

test results. The product of the respirator APF and the exposure limit is the maximum use concentration. However, the maximum use concentration cannot exceed any use limitations for the particular class of respirator.

Ataxia

Defective muscular coordination, especially when voluntary movements are attempted (Ref. 79).

Atmosphere supplying respirator

A respirator that supplies the user with breathing air from a source independent of the ambient atmosphere, and includes supplied air respirators (airline respirators) and self contained breathing apparatus units.

Autopsy

Postmortem examination of the organs and tissues of a body to determine the cause of death or pathological conditions (Ref. 79).

B lymphocytes

A lymphocyte formed from pluripotent stem cells in the bone marrow that migrates to the spleen, lymph nodes, and other peripheral lymphoid tissue where it comes in contact with foreign antigens and becomes a mature functioning cell (Ref. 79). Mature B cells are able to independently identify foreign antigens and differentiate into antibody-producing plasma cells or memory cells (Ref. 79). Memory cells enable the body to produce antibodies quickly when it is invaded by the same organism at a later date (Ref. 79).

Bacilli

Of bacillus

Bacillus

A genus of bacteria of the family Bacillaceae (Ref. 79). All species are rod-shaped, sometimes occurring in chains (Ref. 79). They are spore-bearing, aerobic, motile or nonmotile; most are gram-positive and nonpathogenic (Ref. 79). A well-known species pathogenic to humans is *Bacillus anthracis*, which causes anthrax (Ref. 79).

Bacteremia

Bacteria in the blood (Ref. 79).

Biennial

Occurring once every two years.

Bioaerosol

An aerosol of biological origin (Ref. 92). Bioaerosols include viruses, viable organisms, such as bacteria and fungi, and products of organisms, such as fungal spores and pollen (Ref. 92).

Bloodborne pathogens

Pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to hepatitis B virus and the human immunodeficiency virus (HIV).

Body substance isolation

Body substance isolation incorporate the fluids and materials covered by the bloodborne pathogen standard, and expand coverage to include all moist and potentially infectious body substances from all patients. Body substance isolation requires wearing of gloves where contact with moist body substances are likely and hand washing after glove removal if hands are visibly soiled. Body substance isolation apply to blood, feces, urine, sputum, saliva, wound drainage, and other body fluids.

Breakthrough time

The time it takes a chemical to pass through chemical protective clothing material until it is first detected by an analytical instrument (Ref. 94).

Bronchitis

Inflammation of the mucous membrane of the bronchial airways (Ref. 79).

Bronchoscope

An endoscope designed to pass through the trachea for visual inspection of the tracheobronchial tree (Ref. 79). The device also allows passage of an instrument to remove tissue for biopsy or a foreign body from the tracheobronchial tree (Ref. 79).

Bronchoscopy

Examination of the bronchi through a bronchoscope (Ref. 79).

Carrier

A person or animal that harbors a specific infectious agent without discernible clinical disease and serves as a potential source of infection (Ref. 40). The carrier state may exist in an individual with an infection that is inapparent throughout its course (commonly known as healthy or asymptomatic carrier), or during the incubation period, convalescence and postconvalescence of an individual with a clinically recognizable disease (Ref. 40).

Cascade impactor

A multistage impaction device used to separate airborne particles into aerodynamic size classes.

Cataract

Opacity of the lens of the eye, its capsule, or both (Ref. 79).

Central nervous system

The brain and spinal chord (Ref. 79).

Cerebrospinal fluid

The body fluid associated with the brain and spinal cord.

Chemoprophylaxis

The administration of a chemical, including antibiotics, to prevent the development of an infection or the progression of an infection to active manifest disease, or to eliminate the carriage of a specific infectious agent to prevent transmission and disease in others (Ref. 40).

Chronic effects

Adverse effects that persist over a long period of time. These effects may arise after months or years, may have a long course ranging from relatively mild to severe, or may arise immediately after exposure (Ref. 91). For example, chronic effects would include coming down with lung cancer as result of chronically smoking cigarettes, or coming down with cirrhosis of the liver as a result of chronically drinking excessive amounts of alcohol.

Chronic exposure

Multiple or continuous exposures to relatively small doses over a long period of time or a significant fraction of an individual's lifetime.

Cocci

Plural form of coccus.

Coccus

A bacterial type that is spherical or ovoid.

Cognition

Awareness with perception, reasoning, judgment, intuition, and memory, the mental process by which knowledge is acquired (Ref. 79). A patient with normally functioning mental processes would have insight into his or her illness (Ref. 79).

Cognitive

Of, relating to, or involving cognition

Cohesion

Molecular attraction by which the molecules of a solid or liquid are united throughout the mass. Cohesion forces are the intermolecular forces keeping the molecules in a liquid or solid together, holding them together in a substantially constant volume. Cohesion forces are not different in kind from adhesion forces.

Contact Precautions

Used for patients known or suspected to be infected or colonized with epidemiologically important organisms that can be transmitted by direct contact with the patient or indirect contact with potentially contaminated surfaces in the patient's care area (Ref. 45). Contact precautions require healthcare providers and others to:

- Wear gloves when entering the room (Ref. 48). Change gloves after contact with infective material (Ref. 48).

- Wear a gown when entering the room if contact with patient is anticipated or if the patient has diarrhea, a colostomy or wound drainage not covered by a dressing (Ref. 48).
- Wash hands using an antimicrobial agent (Ref. 45).
- Limit the movement or transport of the patient from the room (Ref. 48).
- Ensure that patient-care items, bedside equipment, and frequently touched surfaces receive daily cleaning (Ref. 48).
- Dedicate use of noncritical patient-care equipment (such as stethoscopes) to a single patient, or cohort of patients with the same pathogen (Ref. 45, Ref. 48). If not feasible, adequate disinfection between patients is necessary (Ref. 45, Ref. 48).

Conventional Diseases requiring Contact Precautions (Ref. 48): Clostridium difficile, parainfluenza, enteroviruses, enteric infections in the incontinent host, skin infections (impetigo, lice, scabies), hemorrhagic conjunctivitis.

Biothreat Diseases requiring Contact Precautions: Viral Hemorrhagic Fevers (Ref. 48, 100), Smallpox (Ref. 45).

Contagious

A disease that is easily transmitted from host to host by casual cutaneous or respiratory droplets (Ref. 79)

Contamination

Any deposit, adsorption, or absorption of radioactive, biological, or chemical substances on and by structures, areas, personnel, objects, soil, and water (Ref. 91).

Cyanosis

Slightly bluish, grayish, slate-like, or dark purple discoloration of the skin caused by the presence of abnormal amounts of reduced hemoglobin in the blood (Ref. 79). This condition is caused by a deficiency of oxygen and an excess of carbon dioxide in the blood, secondary to gas or any condition interfering with the entrance of air into the respiratory tract (Ref. 79). It may also be due to overdoses of certain drugs or to any form of asphyxiation (Ref. 79).

Decontaminate

To breakdown, neutralize, or remove a radioactive, chemical, or biological substance that poses a hazard to personnel or equipment (Ref. 91).

Decontamination Zone (Warm Zone)

The area surrounding the Hot Zone where primary contamination is not expected but where personnel must use protective clothing and equipment to avoid chemical exposure from contaminated victims. This is where people or items are decontaminated as they return from the Hot Zone and before being released to the Support Zone (Cold Zone).

Degradation

The change in the physical properties of chemical protective clothing material as a result of adverse effects of the chemical on the material (Ref. 94). The effect the chemical has as it

interacts with the material can range from no effect to an effect as severe as dissolving the material (Ref. 94).

Diathesis

A constitutional predisposition to certain disease conditions (Ref. 79).

Diffusive diameter

The geometric diameter of an ideal spherical particle with the same diffusivity as the actual particle under identical conditions (Ref. 89).

Disinfection

The reduction of the number of infectious organisms below the level necessary to cause infection (Ref. 47). It involves killing of infectious agents outside the body by direct exposure to heat, liquid chemicals, chemical vapors/gases, or radiation (Ref. 47). Inherent in this definition is the fact that some organisms might survive the activity of the disinfectant, particularly the bacterial spore-forming organisms (Ref. 47). Disinfection may also include use of heat or radiation (Ref. 47).

Doff

To take off or remove.

Don

To put on (as in clothing or equipment).

Droplet infection

Invasion of a pathogenic agent conveyed by particles, as when carried in a spray from the nose or mouth (Ref. 79). This is the usual mode of transmission for the common cold (Ref. 79). Droplet Precautions are used for patients known or suspected to be infected with microorganisms transmitted by large particle droplets (e.g., pneumonic plague), generally larger than 5 μm in size, that can be generated by the infected patient during coughing, sneezing, talking, or during respiratory-care procedures (Ref. 45).

Droplet Precautions

Droplet precautions are used for patients known or suspected to be infected with microorganisms transmitted by large particle droplets, generally larger than 5 μm in size that can be generated by the infected patient during coughing, sneezing, talking, or during respiratory-care procedures (Ref. 45). Droplet precautions include (Ref. 45):

- Placing the patient in a private room or cohorting them with someone with the same infection when private rooms are not available. If cohorting is not feasible, maintain at least 3 feet between infected patients and others. Special air handling is not necessary and doors may remain open.
- Avoiding placement of patient requiring Droplet Precautions in the same room with an immunocompromised patient.

- Requiring healthcare providers and others to wear a surgical-type mask when within 3 feet of the infected patient. Based on local policy, some healthcare facilities require a mask be worn to enter the room of a patient on Droplet Precautions.
- Limiting movement and transport of patients on Droplet Precautions to essential medical purposes only and placing a surgical-type mask on the patient if they need to be moved.

Conventional Diseases requiring Droplet Precautions (Ref. 48): Invasive Haemophilus influenzae and meningococcal disease, drug-resistant pneumococcal disease, diphtheria, pertussis, mycoplasma, influenza, mumps, rubella, parvovirus.

Biothreat Diseases requiring Droplet Precautions (Ref. 45, 48): Pneumonic Plague.

Dyspnea

Air hunger resulting in a labored or difficult breathing, sometimes accompanied by pain (Ref. 79). It is normal when due to vigorous work or athletic activity (Ref. 79).

ED₅₀ (Median Effective Dose)

The dose of a substance that produces a given, defined therapeutic or toxic effect in 50% of the exposed population (Ref. 91).

Edema

Swelling caused by a local or generalized condition in which the body tissues contain an excessive amount of tissue fluid (Ref. 79).

Efficacious

The power to produce a desired effect.

Embryo

1. The young of any organism in an early stage of development (Ref. 79).
2. The stage in prenatal development of a mammal between the ovum and the fetus; in humans, the stage of development between the second and eighth weeks inclusive (Ref. 79).

Enanthem

An eruption on a mucous membrane (Ref. 79).

Endocarditis

Inflammation of the lining membrane of the heart (Ref. 79).

Endotracheal intubation

The insertion of an endotracheal tube through the nose or mouth into the trachea to maintain the airway, to administer an anesthetic gas or oxygen, or to aspirate secretions (Ref. 79).

End-of-service-life indicator

A system that warns the respirator user of the approach of the end of adequate respiratory protection. For example, when that the sorbent is approaching saturation or is no longer effective in removing the chemical from the inhaled air.

Epiglottis

The uppermost cartilage of the larynx, indicated immediately posterior to the root of the tongue (Ref. 79). It covers the entrance of the larynx when the individual swallows, thus preventing food or liquids from entering the airway (Ref. 79).

Exanthem

Any eruption of the skin accompanied by inflammation, such as measles (Ref. 79).

Etiologic agent

A viable microorganism, or its toxin which causes or may cause disease and includes those agents listed in 42 CFR 72.3 of the Department of Health and Human Services regulations, and any material of biological origin that poses a degree of hazard similar to those organisms.

Face to facepiece seal leakage

The inward leakage that occurs through open spaces in the face to facepiece seal of a negative-pressure tight-fitting respirator during inhalation. In some extreme circumstances, inward leakage can occur through the open spaces in the face to facepiece seal of a positive-pressure tight-fitting respirator when the inhalation rate exceeds the air-supply rate – this might occasionally and temporarily occur when inhaling rapidly at high work rates, which can occur sometimes during firefighting (Ref. 115). Photographic recordings of the aerosol deposition patterns on the wearer's face have shown that the leaks may be circular or rectangular shape (Ref. 108). There may also be more than one leak (Ref. 108). Circular or near-circular channels may occur because of wrinkles in the wearer's face; rectangular or slit-shaped leak channels may occur when the respirator does not fit snugly to the face or when the perimeter of the respirator deviates from the facial contour, e.g., near the nose and chin (Ref. 108). Tight-fitting respirators must therefore be properly fit-tested and fit-checked to minimize this leakage.

1. Gases and vapors can readily penetrate through any open spaces in the face to facepiece seal of a tight-fitting respirator.
2. For aerosols, penetration through these open spaces depends upon the particle size distribution of the aerosol. Airborne particles with a smaller AED have a much greater probability of entering through these gaps than do larger particles. Laboratory testing (using half-facepiece respirators on manikins) has demonstrated that the percentage of particles that are outside the respirator and subsequently enter through the leaks and reach the mouth is about 90% to 100% for particle AEDs of 0.1 to 1 μm (Ref. 110). This is because when small particles enter through leaks, they will readily follow the air stream to the nose and mouth. For aerosol particles having AEDs greater than 1 μm , the percentage of particles that enter through leaks and reach the mouth and nose and mouth drops rapidly, and the larger the particle AED, the less probability of that particle reaching the nose or mouth. This is because as particles $> 1 \mu\text{m}$ AED approach or enter the leak sites at the facepiece seal, some will impact on the face (on the outside or inside of the respirator) due to their inertia - that is, due to their larger AED, they do not as readily follow the air stream to the mouth and nose as do smaller particles and may, instead, impact on the face rather than enter through the nose or mouth. Laboratory testing (using half-facepiece respirators on manikins) has demonstrated that the percentage of particles that are

outside the respirator and subsequently enter through the leaks and reach the mouth is about 90% to 100% for particle AEDs of 1 μm , about 55% to 90% for particle AEDs of 4 μm , about 40% to 80% for particle AEDs of 5 μm , and 10% to 40% for particle AEDs of 10 μm (Ref. 110). Thus, proper fit-testing and fit-checking is particularly important when in an atmosphere containing respirable aerosols ($< 10 \mu\text{m}$ AED) when the aerosol composition and concentration is considered potentially hazardous. Proper fit-testing and fit-checking is also important when in an atmosphere contains inhalable aerosols when the aerosol composition and concentration is considered potentially hazardous.

Fasciculation

Involuntary contraction or twitching of muscle fibers, visible under the skin (Ref. 79)

Fever

An oral temperature above a person's normal daily variation (the temperature varies throughout the day and differs between individuals) or, if unknown, $> 100^{\circ}\text{F}$ (Ref. 80). Symptoms include a flushed face; hot, dry skin; appetite loss; malaise; aching all over; headache; nausea (and sometimes vomiting); and chills (Ref. 79). The cause of fever may be infectious or noninfectious (e.g., inflammatory, neoplastic, and immunologically mediated disorders) (Ref. 80). Pyrogens are substances that cause fever; they may be exogenous or endogenous (Ref. 80). Exogenous pyrogens are derived from outside the host; most are microbes (e.g., bacteria, viruses), microbiological products, or toxins (Ref. 80).

Fibrosis

The development in an organ of excess fibrous connective tissue usually in a reparative or reactive process (Ref. 79).

Filtering facepiece respirator

A negative pressure respirator with a particulate filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

Filter

A component used in respirators to remove solid or liquid aerosols from the inspired air.

Fit check (user seal check)

A test conducted by the user of a tight-fitting respirator to ensure the facepiece is properly seated to the face. This test must be done each time a tight-fitting respirator is donned before entering the contaminated atmosphere. This check helps reduce or prevent air contaminate leakage between the users face and facepiece seal.

Fit factor

A quantitative measure of the fit of a particular tight-fitting respirator facepiece to a particular individual, and typically measures the ratio of the concentration of a substance (aerosol) in ambient air to its concentration inside the respirator when worn and tested according to a specific test protocol. HEPA (or Class 100 Filters) are installed on the respirator and it is assumed that either no leakage or only a negligible amount of leakage into the facepiece occurs through the exhalation valve or any source *other than* the between facepiece seal and the face. As an

example, a fit factor of 1000 indicates the aerosol concentration inside the respirator was $1/1000^{\text{th}}$ of the concentration outside the respirator when worn by the person in the laboratory. However, it should be noted that there is no correlation between quantitative fit factors and workplace protection factors (Ref. 105). This is due to the following reasons: differences in the conditions of the fit test and the conditions in the workplace; variations in the position of the facepiece on a person's face after different donnings; variations in equipment and methods of measuring respirator performance during a fit test and during work on a job site; and different face, head, and body movements by the respirator wearer during a fit test and during actual work (Ref. 93). Typically, a minimum quantitative fit factor (e.g., 100, 500, etc.) is chosen for a particular class of respirator to ensure the respirator provides a minimum level of fit to the users face when tested according to a specific protocol in the laboratory, and it assumed that in the workplace, the respirator will provide a protection factor that is at least greater than 1/10 of the quantitative fit factor – i.e., if the quantitative fit factor was 100 in the laboratory, then the respirator is assumed to have a protection factor of at least 10 when actually used in the work environment.

Fit test

Protocol to qualitatively or quantitatively evaluate the fit of a tight-fitting facepiece respirator on an individual. In order for a respirator equipped with a tight-fitting facepiece to provide adequate respiratory protection to its wearer while in a hazardous atmosphere, the facepiece must form a satisfactory seal that minimizes leakage of the hazardous atmosphere into the facepiece where it could be inhaled by the wearer (Ref. 93). Since each individual's face varies in size and shape, the ability of the respirator facepiece to achieve a satisfactory fit on a particular worker's face must be determined by a fit test (Ref. 93).

Flaccid

Weak, lax, and soft.

Fomites

Inanimate objects such as linens, towels, clothing, books, and utensils, which can harbor pathogens and are capable of transmitting them.

Gas

Any material in the gaseous state at 25°C and 760 mm Hg (Ref. 90). Normally, a formless fluid, it expands to the space or enclosure (Ref. 90). Size ranges are usually less than $0.0005\ \mu\text{m}$ (Ref. 90).

Gastrointestinal tract

The mouth, esophagus, stomach, intestines, and related organs (Ref. 90).

Grade “D” breathing air

Breathing air meeting the requirements of the Compressed Gas Association Specification G-7, which includes an oxygen content of 19.5-23.5% by volume, hydrocarbon content of $5\ \text{mg}/\text{m}^3$ or less, carbon monoxide content of 10 parts per million or less, moisture content that does not exceed a dew point of -50 degrees F at one atmosphere or pressure, and a lack of noticeable odor.

Gray (Gy)

The SI unit of absorbed dose (Ref. 57). One gray is equal to an absorbed dose of 1 J/kg (100 rad) (Ref. 57).

Gross decontamination

Removal of the victim's contaminated clothing and following with a 1-minute-long rinsing from head to toe with tepid water. Note: if the victim is contaminated with a pure metal solid or a strong corrosive solid, dry decontamination (i.e, gentle brushing or vacuuming of larger particles) is required before water is applied (Ref. 72).

Head airways region

The upper region of the respiratory tract consisting of the nasal passages, mouth, pharynx, and larynx. This region serves to protect the lung by filtering out large inhaled particles (e.g., by filtration in the nose or inertial impaction with the back of the throat), absorbing particles and gases with very high water solubility, and warming and humidifying the inspired air. Most of the particles that are $> 10 \mu\text{m}$ AED are removed in the head airways region. Deposition of particles in the head airways region is also high for very small particles (less than $0.01 \mu\text{m}$) due to diffusion, especially in the nose – this causes deposition in the tracheobronchial and pulmonary regions to drop off for the smallest particles (Ref. 92).

Hemoptysis

The coughing up of blood derived from the lungs or bronchial tubes as a result of pulmonary or bronchial hemorrhage (Ref. 79).

Hemorrhage

An abnormal, severe internal or external discharge of blood (Ref. 79).

Hemorrhagic

Pertaining to or marked by hemorrhage (Ref. 79).

High efficiency particulate air (HEPA) filter

A filter that is at least 99.97% efficient in removing monodisperse particles of $0.3 \mu\text{m}$ in diameter. For respirators, the equivalent NIOSH 42 CFR 84 particulate filter is the P100 filter. Both P100 and HEPA filters are color-coded magenta. A PAPR can be equipped with a HEPA filter. Non-powered air-purifying respirators can be equipped only with P100 (not HEPA) filters, but P100 particulate filters are considered equivalent to HEPA filters. Vapors and gases are not removed by HEPA or P100 filters, or by any other particulate filter.

Hot Zone (Exclusion Area)

The area surrounding a chemical release. It is assumed to pose an immediate health risk to all persons, including rescuers.

Hygroscopic

Readily absorbing or retaining moisture.

Hypoxemia

Decreased oxygen concentration in the blood (Ref. 79).

ID₅₀ (Median Infective Dose)

Minimum number of particles or agents required to establish in 50% of a group of hosts of the same species (Ref. 47).

ID₅₀ (Median “Incapacitation” Dose)

Dose of a liquid chemical agent needed to produce “incapacitation” in 50% of the exposed subjects (Ref. 91).

Immediately dangerous to life or health

An atmospheric concentration of any toxic, corrosive, or asphyxiant substance that poses an immediate threat to life, would cause irreversible or delayed adverse health effects, or would interfere with an individual’s ability to escape from a dangerous atmosphere.

Immune individual

A person or animal that has specific protective antibodies and/or cellular immunity as a result of previous infection or immunization, or is so conditioned by such previous experience as to respond in such a way that prevents the development of infection and/or clinical illness following reexposure to the specific infectious agent (Ref. 40). Immunity is relative: A level of protection may be overwhelmed by an excessive dose of the infectious agent or by exposure through an unusual portal of entry; protection may also be impaired by immunosuppressive drug therapy, concurrent disease or the aging process (Ref. 40).

Immunocompromised

An immune system with compromised ability to react to pathogens or tissue damage. This may be due to a genetic disorder, disease process, radiation, or drugs such as corticosteroids or immunosuppressive agents given to treat a disorder that inhibits immune function. Immunosuppression (caused by radiation, drugs, stress, certain industrial chemicals, etc.) can decrease an individual’s resistance and increase vulnerability to infection and proliferation of neoplastic or other mutated cells.

Immunosuppression

Suppression of an immune response by the use of drugs or radiation (Ref. 90). Toxic interactions also can cause suppression of the immune response (Ref. 90). Immunosuppression decreases an individual’s resistance and increases vulnerability to infection and proliferation of neoplastic or other mutated cells (Ref. 90).

Impaction

The impacting of a particle onto a surface due to inertia. Due to inertia, larger inhaled particles tend to continue to travel along their original path, whereas smaller particles, vapors, and gasses tend to follow the air stream. The high air velocity and the tortuous nature of the head airway region forces many sharp changes in airflow direction and provides an ideal region for

impaction. Inhaled particles having an AED greater than 10 μm are more likely to be deposited in the head airways by impaction than they are of following the air stream and entering the lung; however, particles as large as 30 μm AED still have a possibility of following the air stream into the trachea, the first conducting airway of the lung.

In Utero

Within the uterus

Inapparent infection

The presence of infection in a host without recognizable clinical signs or symptoms (Ref. 40). Inapparent infections are identifiable only by laboratory means such as a blood test or by the development of positive reactivity to specific skin tests (Ref. 40). Synonyms: asymptomatic, subclinical, occult infection (Ref. 40).

Incubation period

The time interval between initial contact with an infectious agent and the first appearance of symptoms associated with the infection (Ref. 40).

Infected individual

A person or animal that harbors an infectious agent and who has either manifest disease or inapparent infection (Ref. 40). An infectious person or animal is one from whom the infectious agent can be naturally acquired (Ref. 40).

Infectious disease

An illness due to a specific infectious agent or its toxic products that arises through transmission of that agent or its products from an infected person, animal or inanimate reservoir to a susceptible host; either directly or indirectly through an intermediate plant or animal host, vector or the inanimate environment (Ref. 40). Synonym: communicable disease (Ref. 40).

Ingestion

The process of taking in material (particularly food) into the gastrointestinal tract or the process by which a cell takes in foreign particles (Ref. 79).

Inhalable particle fraction

Airborne particles capable of entering the respiratory tract. Airborne particles (in the breathing zone of a person) having an AED of 100 μm have about a 50% chance of entering the respiratory tract (Ref. 18). Airborne particles > 100 μm AED are likely to have less than a 50% chance of entering the respiratory tract. Airborne particles < 100 μm AED have a greater chance of entering the respiratory tract, and the smaller they are, the greater the chance (Ref. 18). For example, an airborne particle (in the breathing zone of a person) of 10 μm AED has about a 77% chance of entering the respiratory tract.

Interception

The deposition of a particle or fiber onto a surface whereby the edge of the particle or fiber contacts the surface and is retained. Due to the length of fibers, interception is a more important

removal mechanism (e.g., such as when collected in the respiratory bronchial tree or onto a filter fiber) for fibers than for spherical particles of equivalent mass.

Ion

An atom that has too many or too few electrons, causing it to be chemically active; an electron that is not associated (in orbit) with a nucleus (Ref. 57).

Ionizing radiation

Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions (Ref. 57). Examples: alpha, beta, gamma, X-rays, neutrons, high-speed electrons, high-speed protons, and ultraviolet light (Ref. 57). High doses of ionizing radiation may produce severe skin or tissue damage (Ref. 57).

Larynx

A musclocartilaginous organ at the upper end of the trachea below the root of the tongue, lined with ciliated mucous membrane; part of the airway and the organ of voice (Ref. 79).

LC₅₀ (Median Lethal Concentration)

The airborne concentration of a given substance that when inhaled over a period of time will kill 50% of the animals under test.

LCt₅₀ (Median Lethal Concentration Multiplied by Exposure Time)

Lethal concentration of a chemical vapor or aerosol for 50% of the population multiplied by exposure time.

LD₅₀ (Median Lethal Dose)

A dose of a substance that produces death in 50% of the exposed population usually as a single dose, with the route of exposure specified.

Linear energy transfer

A measure of the ability of biological material to absorb ionizing radiation; specifically, for charged particles traversing a medium, the energy lost per unit length of path as a result of those collisions with electrons in which the energy is less than a specified maximum value (Ref. 57). A similar quantity may be defined for photons (Ref. 57).

Loose-fitting facepiece

A respirator inlet covering that is designed to form a partial seal with the face.

Lungs

The tracheobronchial and pulmonary regions.

Lymphocyte

A cell present in the blood and lymphatic tissue (Ref. 79). The total cell mass of lymphocytes is equivalent to that of the liver and less than 1% are present in the circulating blood (Ref. 79). These cells travel from the blood to the lymph and lymph nodes and back into the circulation (Ref. 79). Small lymphocytes are 6-9 μm and the largest ones are 9-15 μm in diameter (Ref. 79).

Lymphocytes are derived from the stem cells from which all blood cells arise (Ref. 79). They are the main means of providing the body with immune capability (Ref. 79). This is done by means of humoral immunity produced by B cells and cell-mediated immunity produced by T cells (Ref. 79). The total cell mass of lymphocytes is about equivalent to that of the liver (Ref. 79). In the circulating blood, lymphocytes constitute 20% to 44% of the total white blood cells (Ref. 79).

Macro

Large

Macule

Discolored spot or patch on the skin, neither elevated nor depressed, of various colors, sizes, and shapes (Ref. 79).

Malaise

Discomfort, uneasiness, or indisposition, often indicative of infection (Ref. 79).

Maximum use concentration

The maximum airborne contaminant concentration that a particular class of respirator may be used for protection against. It is the product of the APF for the class of respirator multiplied by the exposure limit for the contaminant of concern, i.e., $MUC = APF \times \text{Exposure Limit}$. For instance, a full facepiece air-purifying respirator with an APF of 50 that was used to protect against an a chemical with an exposure limit of 10 ppm could be used in atmospheres as high as 500 ppm, as long as the atmosphere is not oxygen-deficient or IDLH, the cartridge/canister effectively removes the chemical of concern, and the MUC designated on the cartridge/canister is not exceeded.

Micro

Small

Microorganisms

Minute living bodies that cannot be seen with the naked eye, such as bacteria, viruses, and rickettsias.

Mil

A unit of length equal to $1/1000^{\text{th}}$ of an inch

Minute volume

The volume of air breathed in a minute.

Miosis

Excessive smallness or contraction of the pupil of the eye.

Motile

Having spontaneous movement (Ref. 79).

Mucous membrane

The membrane lining passages and cavities communicating with the air, consisting of epithelium, a basement membrane, and an underlying layer of connective tissue (Ref. 79). Mucus-secreting cells or glands are usually present in the epithelium but may be absent (Ref. 79). For example, the mucous membrane lining inside of the nose, mucous membrane lining the inside of the mouth, and conjunctiva (mucous membrane that lines the eyelids surrounding the eye) (Ref. 79).

Mutation

1. Permanent variation in genetic structure with offspring differing from parents in a characteristic; differentiated from gradual variation through many generations (Ref. 79).
2. A change in a gene potentially capable of being transmitted to offspring (Ref. 79).

N95 filter

A class of filter that is at least 95% efficient in removing solid and water-based particulates (i.e., non-oil aerosols). The “N” prefix indicates that the filter is certified to protect personnel from non-oil based aerosols, such as solid and water-based aerosols. Health care delivery settings are generally free of oil aerosols that would be degrading to N95 filters. More efficient filters (e.g., Class 99; Class 100 or HEPA) may be desired or deemed necessary in some instances. If aerosols contain oil, then R- or P-series filters must be used instead of N95 filters. N95 respirators equipped with elastomeric facepieces and replaceable filters are designed for reuse. A disposable respirator (such as an N95 filtering facepiece respirator) may be reused by the same healthcare worker unless the MTF policy is that gowns and booties are to be disposed of between wear.

- If the MTF policy is that gowns and booties are deemed reusable (doffed, hung on a hook and redonned), then the disposable respirator is reusable by the same healthcare worker. If disposable respirators are deemed reusable by the MTF, then they must be replaced under any of the following conditions:

- (1) Loss of functional and structural integrity.
- (2) Filter material is physically damaged or soiled.
- (3) There are nicks, abrasions, cuts, or creases in the facepiece-to-face sealing material.
- (4) Straps are damaged or cut or not able to be attached to all connection points.
- (5) Metal nose clip (if applicable) is not in place and/or does not function properly.
- (6) Increased breathing resistance causes discomfort to the wearer.
- (7) Total mass loading of the filter is greater than 200 mg.

- If a disposable respirator is used in a MTF to protect healthcare workers from infectious patients that may transmit a disease via the airborne route, follow the following guidelines:

(1) Store the respirators at the entrance to designated isolation areas so that users can pick them up when entering. One method for accomplishing this is to install a box with sufficient compartments for storing all the respirators required in that area. The storage bin would look like a mail box with slots for each user's respirator. Each slot would be labeled with the user's name.

(2) Never store disposable respirators in pockets, plastic bags, or other confined areas.

Necrosis

The death of areas of tissue or bone surrounded by healthy parts (Ref. 79).

Negative pressure respirator

A respirator, with a tight fitting facepiece, in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Nonmotile

Non-moving.

Nonstochastic effects

Effects that show a clear causal relationship between dose and effect in a given person (Ref. 103). Usually there is a threshold below which no effect is observed, and the severity generally increases with the dose (Ref. 103). Skin reddening is a good example of a nonstochastic effect of radiation (Ref. 103).

Nosocomial infection

Infection acquired in the hospital.

Nucleocapsid

In a virus, the protein coat and the viral nucleic acid.

Oropharynx

The central portion of the pharynx lying between the soft palate and the upper portion of the epiglottis.

Oxygen deficient atmosphere

An atmosphere with an oxygen content below 19.5% by volume.

P-100 filter

A highly efficient filter that is considered equivalent to a HEPA filter and that is at least 99.97% efficient in filtering all types of aerosols (including oil mist). Both P100 and HEPA filters are color-coded magenta. P100 and HEPA filters are not interchangeable. Non-powered air-purifying respirators can be equipped only with P100 (not HEPA) filters, but P100 particulate filters are considered to provide equivalent protection to HEPA filters. Powered air-purifying respirators are required to use a HEPA filter. Vapors and gases are not removed by HEPA or P100 filters, or by any other particulate filter.

Papule

A small, red, elevated area on the skin, solid and circumscribed; a pimple (Ref. 79).

Particle

A small discrete object, often having a density approaching the intrinsic density of the bulk material (Ref. 90). It may be chemically homogeneous or contain a variety of chemical species (Ref. 90).

Particulate

Particle of solid or liquid matter.

Passive immunity

Providing temporary protection from disease through the administration of exogenously produced antibody (i.e., transplacental transmission of antibodies to the fetus or the injection of immune globulin for specific preventive purposes) (Ref. 48).

Pathogen

A microorganism or substance capable of producing a disease (Ref. 79).

Penetration

The bulk flow of a chemical through openings in chemical protective clothing as a result of manufacturer defects or user-caused damages, such as tears, rips, pinholes, and other damage (Ref. 94).

Pericardial fluid

The body fluid associated with the sac that surrounds the heart.

Peritoneal fluid

The body fluid associated with the abdominal cavity.

Permeation

Diffusion of a chemical on a molecular basis through chemical protective clothing material (Ref. 94).

Permeation rate

The rate or speed of the movement through chemical protective clothing material once it has broken through (Ref. 94).

Persistent Agent

Chemical agents that do not hydrolyze or volatilize readily, such as VX and HD.

Pharynx

The passageway for air from the nasal cavity to the larynx and for food from the mouth to the esophagus (Ref. 79).

Pleura

A serous membrane that enfolds both lungs and is reflected upon the walls of the thorax and diaphragm (Ref. 79). The pleurae are moistened with a serous secretion that reduces friction during respiratory movements in the lungs (Ref. 79).

Pleural fluid

The body fluid associated with the cavity surrounding the lungs.

Pleurisy

Inflammation of the pleura (Ref. 79).

Pleuritic

Related to or resembling pleurisy (Ref. 79).

Positive pressure respirator

A respirator in which the pressure inside the facepiece exceeds the ambient air pressure outside the respirator, even during inhalation.

Postmortem

Occurring or performed after death (Ref. 79).

Powered air-purifying respirator

An air-purifying respirator that uses a blower to force the ambient atmosphere through air-purifying elements to the inlet covering. Not safe or allowed to be used in IDLH or oxygen-deficient environments.

Pulmonary edema

This is a life threatening condition (Ref. 79). It is the effusion of serous fluid into the alveoli and interstitial tissue of the lungs (Ref. 79). One cause is the weakening or failure of the left ventricle, which allows blood to back up and increase filtration pressure in the pulmonary capillaries (Ref. 79). Also, some TICs can cause damage to the inside linings of the lungs that lead to leaking and edema (or ARDS – acute respiratory distress syndrome). Symptoms include extreme labored or difficult breathing, rapid labored breathing, cough with frothy blood-stained expectoration, cyanosis, and cold extremities (Ref. 79).

Pulmonary region

Lower region of the respiratory tract where gas exchange takes place, consisting of the respiratory bronchioles, alveolar ducts, and alveolar sacs. Larger particles are captured either in the head airways region (e.g., by filtration in the nose or inertial impaction against the back of the throat) or in the tracheobronchial region (e.g., by sedimentation/gravitational settling). Smaller particles not captured in the head airway or tracheobronchial regions penetrate into the pulmonary region.

Pustular

Characterized by pustules, which are small elevations of the skin filled with lymph or pus (Ref. 79).

Qualitative fit test

A pass/fail subjective fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent which, depending on the test agent, may evoke eye, nose, or throat irritation, or have a characteristic odor or taste should the test agent leak inside the respirator.

Quantitative fit test

An assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator. This is an objective (i.e., nonsubjective) test using scientific analytical measuring equipment and a fit factor is determined by this test. See the definition for fit factor for further details.

Respirable particles

Airborne particles that are small enough to enter and deposit in the pulmonary region. Respirable particle deposition in the pulmonary region depends on the particle size, minute volume, tidal volume, and whether the person is breathing through their nose or mouth (Ref. 89, Ref. 92). Inhaled particles $> 10\ \mu\text{m}$ AED are captured in the tracheobronchial and head airways regions. An inhaled particle of $10\ \mu\text{m}$ AED has only a small chance (about 1%) of entering the pulmonary region (Ref. 18). Inhaled particles $< 10\ \mu\text{m}$ AED have a greater chance of entering the pulmonary region (Ref. 18). Inhaled particles between $1\text{-}5\ \mu\text{m}$ AED have a good chance of depositing in the pulmonary region by sedimentation (gravitational settling) (Ref. 89, Ref. 92). During mouth breathing, inhaled particles between $3\text{-}4\ \mu\text{m}$ AED have about a 50% chance of depositing in the pulmonary region (Ref. 89, Ref. 92). During nose breathing, inhaled particles between $3\text{-}5\ \mu\text{m}$ AED have a particle deposition rate in the pulmonary region that is about one-half the deposition rate when inhaled through the mouth (Ref. 92) – breathing through the nose can therefore be very effective in reducing the pulmonary dose of inhaled particles in this size range (Ref. 92). Breathing through the nose will also reduce the pulmonary dose of particles between $1\text{-}3\ \mu\text{m}$ AED (Ref. 92). When particles between $1\text{-}4\ \mu\text{m}$ AED are inhaled through the nose, the particle deposition rate in the pulmonary region is about the same (about 20%) for the particles in this size range, though it is slightly higher in the $2\text{-}3\ \mu\text{m}$ AED range (about 25%) than $1\text{-}2\ \mu\text{m}$ AED range (20-25%) and $3\text{-}4\ \mu\text{m}$ AED range (20-25%) (Ref. 92). Penetration into the pulmonary region for particles less than $1\ \mu\text{m}$ AED is close to 100%, but deposition varies sharply (Ref. 89). Inhaled particles between $0.1\ \mu\text{m}$ to $1\ \mu\text{m}$ have a low chance (about 10-20%) of depositing in the pulmonary region (ref. 92), particularly particles with diffusive or physical diameter equal to about $0.3\ \mu\text{m}$ to $0.5\ \mu\text{m}$ which are least influenced by either inertial or diffusion forces (Ref. 89). At the low air velocities and small dimensions in this region, gas diffusion is a faster transport mechanism than flow (Ref. 92). Inhaled particles between $0.1\ \mu\text{m}$ to $1\ \mu\text{m}$ are not directly deposited in the alveolar region because their settling is too low and their diffusion is orders of magnitude slower than gas molecules (Ref. 92). The deposition of these particles is controlled by their transfer from inhaled air to the reserve air in the tracheobronchial region, followed by settling from the trapped reserve air in the pulmonary region (Ref. 92). Consequently, particles between $0.1\ \mu\text{m}$ to $1\ \mu\text{m}$ AED deposit in the pulmonary region at a rate that is approximately independent of size (Ref. 92). Inhaled “ultrafine” particles with diffusional or physical sizes from $0.01\ \mu\text{m}$ to $0.1\ \mu\text{m}$ have a greater chance of depositing in the pulmonary region than particles between $0.1\ \mu\text{m}$ to $1\ \mu\text{m}$ because they are more influenced by

diffusion forces, and therefore these smaller particles would result in a significantly higher dose (deposited particles) than particles of 0.3 μm to 0.5 μm of equivalent concentrations (Ref. 89). Likewise, inhaled particles between 1-5 μm AED have a much better chance of depositing in the pulmonary region than particles between 0.1 μm to 1 μm because they are more influenced by sedimentation (gravitational settling forces), and therefore these larger particles would result in a significantly higher dose (deposited particles) than particles of 0.3 μm to 0.5 μm of equivalent concentrations (Ref. 89). Deposition of inhaled particles in the tracheobronchial and pulmonary regions drops off for very small particles (less than 0.01 μm) due to diffusion in the head airway region, especially in the nose (Ref. 92).

Respiratory tract

The breathing airways consisting of the head airways region, tracheobronchial region, and pulmonary region.

Rhinorrhea

A thin watery discharge from the nose (Ref. 79).

Rickettsiae

Small pleomorphic coccobacilli that can only multiply within susceptible host cells (Ref. 47). Most of them require an arthropod host for perpetuation in nature (Ref. 47).

Rigor

1. A sudden paroxysmal chill with high temperature, called the cold stage, followed by a sense of heat and profuse perspiration, called the hot stage (Ref. 79).
2. A state of hardness and stiffness, as in a muscle (Ref. 79).

Secondary decontamination

A thorough and deliberate decontamination of victims, making the patient as clean as possible. Secondary or definitive decontamination usually includes washing with a mild soap (e.g., dishwashing detergent), tepid water (slightly warm, not hot!), and soft sponges (no stiff brushes, abrasives, or vigorous scrubbing!) in an organized and thorough manner (Ref. 69, Ref. 72). Note: if the victim is contaminated with a pure metal solid or a strong corrosive solid, dry decontamination (i.e, gentle brushing or vacuuming of larger particles) is required before water is applied (Ref. 72).

Sedimentation

The movement of an aerosol particle through a gaseous medium (e.g., air) under the influence of gravity. Sedimentation (i.e., gravitational settling) is the dominant deposition mechanism for inhaled particles that are from 1-30 μm AED and have entered the tracheobronchial region. Aerosols (released outside the human body in the ambient air) having AED of about 1-100 μm are also removed from the air primarily by gravitational settling, and the smaller the particle AED, the longer it takes for the particle to settle out onto surfaces. The rate at which a particle settles is a function, of the size, shape, and density of the particle. The physical diameter has the greatest impact on the settling rate and is a function of the diameter squared. For instance, spherical particles having a density of 1 g/cc and having physical diameters of 4 μm , 10 μm , or 100 μm , would settle out onto surfaces at rates of 16-, 100-, and 1000-times faster, respectively,

then spherical particles of equivalent density but having physical diameters of 1 μm . The density has a lesser impact on the settling velocity than does the physical diameter and is directly proportional to the density. For instance, a spherical particle having a density of 10 g/cc would fall at a rate of 10-times faster than a spherical particle having the same physical diameter but having a density of 1 g/cc.

Self contained breathing apparatus

An atmosphere supplying respirator for which the source of breathing air is designed to be carried by the user.

Septicemia

The presence of pathogenic microorganisms in the blood (Ref. 79).

Sharps

Needles or other sharp objects.

Somatic effects

Effects that pertain to non-reproductive cells or tissues.

Sputum

A substance expelled by coughing or clearing the throat (Ref. 79). It may contain a variety of material from the respiratory tract including one or more of the following: cellular debris, mucus, blood, pus, caseous material, and microorganism (Ref. 79).

Standard Precautions

Standard precautions combine the major features of universal precautions and body substance isolation. They were developed to reduce the risk of transmission of microorganisms from recognized and unrecognized sources in hospitals. Standard precautions apply to blood and body fluids, secretions, and excretions (except sweat) whether or not they contain visible blood; non-intact skin; mucous membranes such as those in the eyes, nose, and mouth. Standard Precautions are employed in the care of ALL patients (Ref. 48). For PPE used in Standard Precautions, consult Chapter 5, paragraph 5.3

Sterilization

The complete killing of all organisms (Ref.47). Sterilization is achieved by physical sterilization (i.e., heat or radiation) or by chemical sterilization (i.e., liquid chemicals or chemical gases/vapors) (Ref. 47).

Stochastic effects

Effects that occur in a statistical manner (Ref. 103). Cancer is one example. If a large population is exposed to a significant amount of a carcinogen, such as radiation, then an elevated incidence of cancer can be expected (Ref. 103).

Stridor

A high-pitched harsh sound heard during respiration (Ref. 79). It resembles the blowing of wind due to obstruction of the upper airway (Ref. 79).

Stokes diameter

Diameter of a spherical particle with the same density and settling velocity as the particle in question.

Supplied air respirator (or airline respirator)

An atmosphere supplying respirator for which the source of breathing air is not designed to be carried by the user.

Support Zone (Cold Zone)

The outermost ring surrounding a chemical release. It is outside the Hot Zone and Decontamination Zone. No exposure or risk is expected in this zone. After people or items are decontaminated (as they return from the Hot Zone) in the Decontamination Zone, they are transferred to the Support Zone. The incident commander, medical personnel, and other support persons and equipment operate in this zone.

Susceptible

A person or animal not possessing sufficient resistance against a particular pathogenic agent to prevent contracting infection or disease when exposed to the agent (Ref. 40).

Suspect

In infectious disease control, illness in a person whose history and symptoms suggest that he or she may have or be developing a communicable disease (Ref. 40).

Synovial fluid

The body fluid contained in the joint cavities, bursae and tendon sheaths.

Systemic effects

Adverse effects other than at the site of contact (Ref. 90).

Target organs

1. The organ of the body most affected by exposure to a particular substance (Ref. 90).
2. The body organs that are affected by exposure to a hazardous chemical, physical, or biological agent.

Tepid

Slightly warm; lukewarm (Ref. 79).

Teratogenic

Causing abnormal development of the embryo (Ref. 79).

Thoracic particle fraction

Fraction of those particles small enough to pass the larynx and enter the lungs, consisting of the tracheobronchial and pulmonary regions. An airborne particle of 25 μm AED has only about a 2% chance of entering the thoracic/lung region and a much higher chance of being captured in the head airways region (Ref. 18). Airborne particles smaller than 25 μm AED have a greater

chance of entering the thoracic/lung region (Ref. 18). For instance, an airborne particle of 10 μm AED has about a 50% chance of entering the thoracic/lung region (Ref. 18). Airborne particles < 10 μm AED have an even greater chance (Ref. 18). For example, an airborne particle of 2 μm AED, has about a 94% chance of entering the thoracic/lung region.

Tidal volume

The volume of air inspired and expired in a normal breath (Ref. 79).

Tight-fitting facepiece

Respiratory inlet covering that forms a complete seal with the face.

Toxin

Toxic material of biologic origin that has been isolated from the parent organism. The toxic material of plants, animals, or microorganisms.

Toxoid

A modified bacterial toxin that has been rendered nontoxic (commonly with formaldehyde) but retains the ability to stimulate the formation of antitoxins (antibodies) and thus producing an active immunity (Ref. 48). Examples include Botulinum, tetanus, and diphtheria toxoids (Ref. 48).

Tracheobronchial region

Middle region of the respiratory tract consisting of the conducting airways between the pharynx and the pulmonary region. Larger particles are captured in the head airways region (e.g., by filtration in the nose or by inertial impaction with the back of the throat). Smaller particles not captured in the head airways enter the tracheobronchial region. This region is lined with epithelial cells and is coated with a thin layer of mucus produced by a variety of secretory cells along the conducting airways. The beating of cilia moves this “mucous blanket” upward, whereby trapped particles are then carried to the oral cavity, where they are subsequently expectorated or swallowed.

Thrombosis

The formation, development, or existence of a blood clot or thrombus within the vascular system (Ref. 79).

Universal Precautions

A method of infection control in which all human blood and certain body fluids are treated as if they are known to be infectious for HIV, HBV, and other bloodborne pathogens. This includes the use of engineering controls, PPE, and safe work practices. For PPE used in Universal Precautions, consult Chapter 14, paragraph 14.3

User seal (or fit) check

An action conducted by the user of a tight-fitting respirator to determine if the respirator is properly sealed to the face. Usually consists of a negative and positive pressure check conducted each time the respirator is donned.

Vaccine

A suspension of attenuated live or killed microorganisms (bacteria, viruses, or rickettsiae), or fractions thereof, administered to induce immunity and thereby prevent infectious disease (Ref. 48).

Vapor

Gaseous phase of a substance ordinarily liquid or solid at 25 ° C and 760 mm Hg (Ref. 90). Evaporation is the process by which a liquid changes to a vapor state, and mixes with the surrounding atmosphere (Ref. 90). Solvents with low boiling points evaporate readily (Ref. 90). Size ranges are usually less than 0.005 µm (Ref. 90).

Vesicating

The process of blistering.

Vesicle

A blister-like small elevation on the skin containing serous fluid (consisting mostly of serum, the watery portion of the blood after coagulation) (Ref. 79).

Volatility

1. The tendency or ability of a liquid to vaporize (Ref. 90). Such liquids as alcohol and gasoline, because of their well-known tendency to evaporate rapidly, are called volatile liquids (Ref. 90).
2. A measure of how quickly a substance forms a vapor at ordinary temperatures (Ref. 90).

Voluntary respirator use

When a worker elects to wear a respirator but use is NOT required by the employer (e.g., the safety and health personnel believes the air contaminant concentration or subsequent dose does not pose a significant health risk to those exposed, such as when personal air sampling indicates exposures are less than an exposure limit, etc.):

1. An employer may provide respirators at the request of employees or permit employees to use their own respirators, if the employer determines that such respirator use will not in itself create a hazard. If the employer determines that any voluntary respirator use is permissible, the employer shall provide the respirator users with the information contained Appendix D of OSHA's respiratory protection regulation, 29CFR 1910.134.
2. The employer must establish and implement those elements of a written respiratory protection program necessary to ensure that any employee using a respirator voluntarily is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user. Exception: Employers are not required to include in a written respiratory protection program those employees whose only use of respirators involves the voluntary use of filtering facepieces (dust masks).

Workplace protection factor

A measure of the actual protection provided in the workplace under the conditions of that workplace by a properly functioning respirator when correctly worn and used. It is defined as the ratio of the airborne contaminant concentration outside the respirator facepiece to the airborne contamination inside the respirator facepiece.

APPENDIX B

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APPENDIX C

OSHA/EPA PPE Levels

The following was extracted from Appendix B (General description and discussion of the levels of protection and protective gear) of 29 CFR 1910.120 (Hazardous Waste and Emergency Operations), as found at the following website: http://www.osha.gov/OshStd_data/1910_0120_APP_B.html

This appendix sets forth information about personal protective equipment (PPE) protection levels which may be used to assist employers in complying with the PPE requirements of this section.

As required by the standard, PPE must be selected which will protect employees from the specific hazards which they are likely to encounter during their work on-site.

Selection of the appropriate PPE is a complex process which should take into consideration a variety of factors. Key factors involved in this process are identification of the hazards, or suspected hazards; their routes of potential hazard to employees (inhalation, skin absorption, ingestion, and eye or skin contact); and the performance of the PPE materials (and seams) in providing a barrier to these hazards. The amount of protection provided by PPE is material-hazard specific. That is, protective equipment materials will protect well against some hazardous substances and poorly, or not at all, against others. In many instances, protective equipment materials cannot be found which will provide continuous protection from the particular hazardous substance. In these cases the breakthrough time of the protective material should exceed the work durations.

Other factors in this selection process to be considered are matching the PPE to the employee's work requirements and task-specific conditions. The durability of PPE materials, such as tear strength and seam strength, should be considered in relation to the employee's tasks. The effects of PPE in relation to heat stress and task duration are a factor in selecting and using PPE. In some cases layers of PPE may be necessary to provide sufficient protection, or to protect expensive PPE inner garments, suits or equipment.

The more that is known about the hazards at the site, the easier the job of PPE selection becomes. As more information about the hazards and conditions at the site becomes available, the site supervisor can make decisions to up-grade or down-grade the level of PPE protection to match the tasks at hand.

The following are guidelines which an employer can use to begin the selection of the appropriate PPE. As noted above, the site information may suggest the use of combinations of PPE selected from the different protection levels (i.e., A, B, C, or D) as being more suitable to the hazards of the work. It should be cautioned that the listing below does not fully address the performance of the specific PPE material in relation to the specific hazards at the job site, and that PPE selection, evaluation and re-selection is an ongoing process until sufficient information about the hazards and PPE performance is obtained.

Part A. Personal protective equipment is divided into four categories based on the degree of protection afforded. (See Part B of this appendix for further explanation of Levels A, B, C, and D hazards.)

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

The following constitute Level A equipment; it may be used as appropriate;

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

Footnote(1) Optional, as applicable.

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

The following constitute Level B equipment; it may be used as appropriate.

1. Positive pressure, full-facepiece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA (NIOSH approved).
2. Hooded chemical-resistant clothing (coveralls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.(1)
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).(1)
8. Hard hat.(1)
9. [Reserved]
10. Face shield.(1)

Footnote(1) Optional, as applicable.

III. Level C - The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air-purifying respirators are met.

The following constitute Level C equipment; it may be used as appropriate.

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

Footnote(1) Optional, as applicable.

IV. Level D - A work uniform affording minimal protection: used for nuisance contamination only.

The following constitute Level D equipment; it may be used as appropriate:

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

Footnote(1) Optional, as applicable.

Part B. The types of hazards for which levels A, B, C, and D protection are appropriate are described below:

I. Level A - Level A protection should be used when:

1. 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 skin,
2. Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible; or
3. Operations must be conducted in confined, poorly ventilated areas, and the absence of conditions requiring Level A have not yet been determined.

II. Level B – Level B protection should be used when:

1. The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection.
2. The atmosphere contains less than 19.5 percent oxygen; or

3. 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 skin.

Note: This involves atmospheres with IDLH concentrations of specific substances that present severe inhalation hazards and that do not represent a severe skin hazard; or that do not meet the criteria for use of air-purifying respirators.

III. Level C - Level C protection should be used when:

1. The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin;
2. The types of air contaminants have been identified, concentrations measured, and an air-purifying respirator is available that can remove the contaminants; and
3. All criteria for the use of air-purifying respirators are met.

IV. Level D - Level D protection should be used when:

1. The atmosphere contains no known hazard; and
2. 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 protective 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.

As an aid in selecting suitable chemical protective clothing, it should be noted that the National Fire Protection Association (NFPA) has developed standards on chemical protective clothing. The standards that have been adopted by include:

NFPA 1991 - Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies (EPA Level A Protective Clothing)

NFPA 1992 - Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies (EPA Level B Protective Clothing)

NFPA 1993 - Standard on Liquid Splash-Protective Suits for Non-emergency, Non-flammable Hazardous Chemical Situations (EPA Level B Protective Clothing)

These standards apply documentation and performance requirements to the manufacture of chemical protective suits. Chemical protective suits meeting these requirements are labeled as compliant with the appropriate standard. It is recommended that chemical protective suits that meet these standards be used. [59 FR 43268, Aug. 22, 1994]

APPENDIX D

INTERAGENCY BOARD PPE LEVELS AND STANDARDIZED LIST FOR WEAPONS OF MASS DESTRUCTION TERRORISM

The following was extracted from the InterAgency Board (IAB) STANDARIZED EQUIPMENT LIST (SEL) FOR 2001 FOR INTERAGENCY RESPONSE OPERATIONS IN COMBATTING WEAPONS OF MASS DESTRUCTION TERRORISM. The SEL is a publication of the IAB for Equipment Standardization and InterOperability. The Department of Defense's Consequence Management Program Integration Office and the Department of Justice's Federal Bureau of Investigation Weapons of Mass Destruction Countermeasures Unit founded the IAB with its first meeting on 13 October 1998, with thankful participation by various local, state, and federal government organizations, and immediately embarked upon a collective effort to standardize weapons of mass destruction response equipment. The IAB is an advisory board to the Attorney General of the United States and the Director of Military Support, and consists of officials from various local, state, and federal government organizations. The IAB is commissioned by the Attorney General of the United States to ensure and interoperability of equipment, and the research and development of advanced technologies, to assist First Responders at the state and local levels in establishing and maintaining a robust crisis and consequence management capability. The SEL is a guideline and its use is voluntary. The SEL should be used by first responders when developing and acquiring their WMD response equipment. The SEL promotes interoperability and standardization among the response community at the local, state, and federal levels by presenting this standard reference. Individual government agencies dictate quantities of the items to be selected to meet the needs of their operational areas. The SEL is organized into categories of PPE, Operational Equipment, Explosive Device Mitigation and Remediation, InterOperable communications and Information Systems, Detection, Decontamination, and Medical. The SEL 2001 can be found at the following website:

<http://www.iab.gov/SEL/sel2001.htm>

Personal Protective Equipment is worn to protect the individual from hazardous materials and contamination. Levels of Protection vary and are divided into three categories based on the degree of protection afforded. The following constitutes equipment intended for use in CB threat environment.

***Level A.* Fully encapsulated, liquid and vapor protective ensemble selected when the highest level of skin, respiratory, and eye protection is required. The following constitutes Level A equipment for consideration:**

- 010A-001** Fully Encapsulated Liquid and Vapor Protection Ensemble, reusable or disposable (tested and certified against CB threats)
- 010A-002** Fully Encapsulated Training Suits
- 010A-003** Testing Equipment for fully encapsulated suits
- 010A-004** Closed-Circuit Rebreather (minimum 2-hour supply, preferred), or open-circuit SCBA or, when appropriate, Air-Line System with 15-minute minimum escape SCBA
- 010A-005** Spare Cylinders/Bottles for rebreathers or SCBA and service/repair kits
- 010A-006** Chemical Resistant Gloves, including thermal, as appropriate to hazard
- 010A-007** Personal Cooling System; Vest or Full Suit with support equipment needed for maintaining body core temperature within acceptable limits
- 010A-008** Hardhat
- 010A-009** Chemical/Biological Protective Undergarment (fire resistant optional)
- 010A-010** Inner Gloves
- 010A-011** Approved Chemical Resistant Tape
- 010A-012** Chemical Resistant Boots, Steel or Fiberglass Toe and Shank
- 010A-013** Chemical Resistant Outer Booties
- 010A-014** Land Mobile, Two-Way In-Suit Communications (secure, hands-free, fully duplex, optional). See ICIS Section Specifications.
- 010A-015** Personnel Alert Safety System (PASS) - (location and physiological monitoring systems optional)
- 010A-016** Personnel Accountability System
- 010A-017** HAZMAT gear bag/box

Level B. Liquid splash resistant ensemble used with highest level of respiratory protection. The following constitute Level B equipment and should be considered for use:

- 010B-001** Liquid Splash Resistant Chemical Clothing, encapsulated or non-encapsulated
- 010B-002** Liquid Splash Resistant Hood
- 010B-003** Closed-Circuit Rebreather (minimum 2-hour supply, preferred), open-circuit SCBA, or when appropriate, Air-Line System with 15-minute minimum escape SCBA
- 010B-004** Spare Cylinders/Bottles for rebreathers or SCBA (NIOSH-approved) and service/repair kits
- 010B-005** Chemical Resistant Gloves, including thermal, as appropriate to hazard
- 010B-006** Personal Cooling System; Vest or Full Suit with support equipment needed for maintaining body core temperature within acceptable limits
- 010B-007** Hardhat
- 010B-008** Chemical/Biological Protective Undergarment (fire resistant optional)
- 010B-009** Inner Gloves
- 010B-010** Approved Chemical Resistant Tape
- 010B-011** Chemical Resistant Boots, Steel or Fiberglass Toe and Shank
- 010B-012** Chemical Resistant Outer Booties
- 010B-013** Land Mobile, Two-Way In-Suit Communications (secure, hands-free, fully duplex, optional). See ICIS Section Specifications.
- 010B-014** Personnel Alert Safety System (PASS) - (location and physiological monitoring systems optional)
- 010B-015** Personnel Accountability System
- 010B-016** HAZMAT Gear Bag/Box

Level C. Liquid Splash resistant ensemble, with same level of skin protection of Level B, used when the concentration(s) and type(s) of airborne substances(s) are known and the criteria for using air-purifying respirators are met. The following constitute Level C equipment and should be considered for use:

- 010C-001** Liquid Chemical Splash Resistant Clothing (permeable or non-permeable)
- 010C-002** Liquid Chemical Splash Resistant Hood (permeable or non-permeable)
- 010C-003** Tight-fitting, Full Facepiece, Negative Pressure Air Purifying Respirator with the appropriate cartridge(s) or canister(s) and P100 filter(s) for protection against toxic industrial chemicals, particulates, and military specific agents.
- 010C-004** Tight-fitting, Full Facepiece, Powered Air Purifying Respirator (PAPR) or PAPR with chemically resistant hood with appropriate cartridge(s) or canister(s) and high-efficiency filter(s) for protection against toxic industrial chemicals, particulates, and military specific agents.
- 010C-005** Equipment or System Batteries will include those that are rechargeable (e.g. NiCad) or non-rechargeable with extended shelf life (e.g. Lithium)
- 010C-006** Chemical Resistant Gloves, including thermal, as appropriate to hazard
- 010C-007** Personal Cooling System; Vest or Full Suit with support equipment
- 010C-008** Hardhat
- 010C-009** Inner Chemical/Biological Resistant Garment (fire resistant optional)
- 010C-010** Inner Gloves
- 010C-011** Chemical Resistant Tape
- 010C-012** Chemical Resistant Boots, Steel or Fiberglass Toe and Shank
- 010C-013** Chemical Resistant Outer Booties
- 010C-014** Land Mobile, Two-Way In-Suit Communications (secure, hands-free, fully duplex, optional) See ICIS Section Specifications.
- 010C-015** Extraction Gear
- 010C-016** HAZMAT Gear Bag/Box
- 010C-017** Personal Alert Safety System (PASS) - (location and physiological monitoring systems optional)
- 010C-018** Personnel Accountability System

Note: During WMD response operations, the Incident Commander determines the appropriate level of personal protective equipment. The United States Environmental Protection Agency (EPA) [Actually these levels are called out in 29 CFR 1910.120, Appendix B] has outlined four (4) levels of protection: A, B, C, and D. The EPA defined these levels of protection primarily for workers at hazardous waste site activities, where emergency conditions typically do not exist. These EPA defined levels of protection are commonly and often inappropriately utilized by the fire service and emergency response organizations. They are inadequate and do not correctly define the chemical protective ensemble with respect to its intended use based on the hazard. For hazardous materials emergency response, the only acceptable types of chemical protective clothing include totally encapsulating and non-encapsulating ensembles offering specific levels of vapor and/or liquid hazard threat protection. The EPA descriptions apply to how an ensemble is designed, not its performance. On the other hand, the National Fire Protection Association (NFPA) has classified hazardous materials protective ensembles by their performance in three (3) standards:

- NFPA 1991 Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies
- NFPA 1992 Standard on Liquid Splash-Protective Clothing for Hazardous Materials Emergencies
- NFPA 1994 Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents

EPA levels of protection should be used only as the starting point for ensemble creation. However, each ensemble must be tailored to meet the specific situation in order to provide the most appropriate level of protection. Emergency response and public safety organizations should conduct a hazard assessment and threat analysis for their jurisdictions. Protective ensembles and respiratory protective equipment (those certified as meeting NFPA and NIOSH minimum performance standards) should then be procured. Personnel entering Protective Postures must also undergo medical monitoring prior to and after entry.

APPENDIX E

CDC Interim Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents

The following was extracted from the CDC Interim Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents, as found at the following website, <http://www.bt.cdc.gov/DocumentsApp/Anthrax/Protective/10242001Protective.doc>, and may be used for PPE guidance at the incident site, but is not applicable to other portions of this document such as at the MTF unless the MTF is part of the incident site. At some point (as the science and expert consensus develops), USACHPPM may provide recommendations that consider the factors described in paragraphs 1.2 and 5.3.5.E. Until then, however, follow the following guidance.

CDC Interim Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents

The approach to any potentially hazardous atmosphere, including biological hazards, must be made with a plan that includes an assessment of hazard and exposure potential, respiratory protection needs, entry conditions, exit routes, and decontamination strategies. Any plan involving a biological hazard should be based on relevant infectious disease or biological safety recommendations by the Centers for Disease Control and Prevention (CDC) and other expert bodies including emergency first responders, law enforcement, and public health officials. The need for decontamination and for treatment of all first responders with antibiotics or other medications should be decided in consultation with local public health authorities.

This INTERIM STATEMENT is based on current understanding of the potential threats and existing recommendations issued for biological aerosols. CDC makes this judgment because:

1. Biological weapons may expose people to bacteria, viruses, or toxins as fine airborne particles. Biological agents are infectious through one or more of the following mechanisms of exposure, depending upon the particular type of agent: inhalation, with infection through respiratory mucosa or lung tissues; ingestion; contact with the mucous membranes of the eyes, or nasal tissues; or penetration of the skin through open cuts (even very small cuts and abrasions of which employees might be unaware). Organic airborne particles share the same physical characteristics in air or on surfaces as inorganic particles from hazardous dusts. This has been demonstrated in military research on biological weapons and in civilian research to control the spread of infection in hospitals.
2. Because biological weapons are particles, they will not penetrate the materials of properly assembled and fitted respirators or protective clothing.

3. Existing recommendations for protecting workers from biological hazards require the use of half-mask or full facepiece air-purifying respirators with particulate filter efficiencies ranging from N95 (for hazards such as pulmonary tuberculosis) to P100 (for hazards such as hantavirus) as a minimum level of protection.
4. Some devices used for intentional biological terrorism may have the capacity to disseminate large quantities of biological materials in aerosols.
5. Emergency first responders typically use self-contained breathing apparatus (SCBA) respirators with a full facepiece operated in the most protective, positive pressure (pressure demand) mode during emergency responses. This type of SCBA provides the highest level of protection against airborne hazards when properly fitted to the user's face and properly used. National Institute for Occupational Safety and Health (NIOSH) respirator policies state that, under those conditions, SCBA reduces the user's exposure to the hazard by a factor of at least 10,000. This reduction is true whether the hazard is from airborne particles, a chemical vapor, or a gas. SCBA respirators are used when hazards and airborne concentrations are either unknown or expected to be high. Respirators providing lower levels of protection are generally allowed once conditions are understood and exposures are determined to be at lower levels.

Interim Recommendations for the selection and use of protective clothing and respirators against biological agents.

When using respiratory protection, the type of respirator is selected on the basis of the hazard and its airborne concentration. For a biological agent, the air concentration of infectious particles will depend upon the method used to release the agent. Current data suggest that the self-contained breathing apparatus (SCBA) which first responders currently use for entry into potentially hazardous atmospheres will provide responders with respiratory protection against biological exposures associated with a suspected act of biological terrorism.

Protective clothing, including gloves and booties, also may be required for the response to a suspected act of biological terrorism. Protective clothing may be needed to prevent skin exposures and/or contamination of other clothing. The type of protective clothing needed will depend upon the type of agent, concentration, and route of exposure.

The interim recommendations for personal protective equipment, including respiratory protection and protective clothing, are based upon the anticipated level of exposure risk associated with different response situations, as follows:

1. Responders should use a NIOSH-approved, pressure-demand SCBA in conjunction with a Level A protective suit in responding to a suspected biological incident where any of the following information is unknown or the event is uncontrolled:
 - the type(s) of airborne agent(s);
 - the dissemination method;

- if dissemination via an aerosol-generating device is still occurring or it has stopped but there is no information on the duration of dissemination, or what the exposure concentration might be.
2. Responders may use a Level B protective suit with an exposed or enclosed NIOSH-approved pressure-demand SCBA if the situation can be defined in which:
 - the suspected biological aerosol is no longer being generated;
 - other conditions may present a splash hazard.
 3. Responders may use a full facepiece respirator with a P100 filter or powered air-purifying respirator (PAPR) with high efficiency particulate air (HEPA) filters when it can be determined that:
 - an aerosol-generating device was not used to create high airborne concentration,
 - dissemination was by a letter or package that can be easily bagged.
- These type of respirators reduce the user's exposure by a factor of 50 if the user has been properly fit tested.

Care should be taken when bagging letters and packages to minimize creating a puff of air that could spread pathogens. It is best to avoid large bags and to work very slowly and carefully when placing objects in bags. Disposable hooded coveralls, gloves, and foot coverings also should be used. NIOSH recommends against wearing standard firefighter turnout gear into potentially contaminated areas when responding to reports involving biological agents.

Decontamination of protective equipment and clothing is an important precaution to make sure that any particles that might have settled on the outside of protective equipment are removed before taking off gear. Decontamination sequences currently used for hazardous material emergencies should be used as appropriate for the level of protection employed. Equipment can be decontaminated using soap and water, and 0.5% hypochlorite solution (one part household bleach to 10 parts water) can be used as appropriate or if gear had any visible contamination. Note that bleach may damage some types of firefighter turnout gear (one reason why it should not be used for biological agent response actions). After taking off gear, response workers should shower using copious quantities of soap and water.

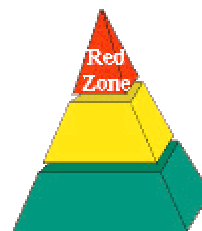
APPENDIX F

OSHA GUIDANCE (INCLUDING PPE) FOR ANTHRAX IN THE WORKPLACE

The following information was extracted from OSHA Guidance on Anthrax in the Workplace, <http://www.osha.gov/bioterrorism/anthrax/matrix/pyramid.html> and may be used for PPE guidance at the incident site, but is not applicable to other portions of this document such as at the MTF unless the MTF is part of the incident site. At some point (as the science and expert consensus develops), USACHPPM may provide recommendations that consider the factors described in paragraphs 1.2 and 5.3.5.E. Until then, however, follow the following guidance.

RED ZONE:

Workplaces Where Authorities Have Informed You That Contamination with Anthrax Spores Has Been Confirmed or Is Strongly Suspected



Red zone guidance addresses two situations:

- The employer is notified by law enforcement or public health authorities that a facility is strongly suspected of or confirmed as having been contaminated with anthrax spores.
- The employer is engaged in emergency response to and clean-up of bio-terrorist releases of anthrax spores.

Notification of an Exposure Incident by Authorities

Actions taken by an employer under these circumstances may vary depending on the specific facts and the nature of the incident. Employers should follow instructions given by law enforcement and public health agencies and convey appropriate information to employees.

Emergency Responders, Clean-up Personnel, and Investigators

Recommended Work Practices

- Emergency response to, and investigation and clean-up of sites contaminated through bio-terrorist acts is specialized work that must be performed by highly trained and qualified personnel.
- OSHA's Hazardous Waste Operations and Emergency Response Standard, also known as HAZWOPER, ([29 CFR 1910.120](#)) applies to these operations. The HAZWOPER standard protects workers who respond to uncontrolled or emergency releases of hazardous substances and clean-up of sites contaminated with these substances. Under the standard, the definition

of hazardous substances includes both chemicals and biological agents, and a bacterium like anthrax, which can cause disease and death, is covered under the definition.

- The HAZWOPER standard provides protection through common sense requirements like emergency planning, training, exposure monitoring, and exposure control through protective measures such as work practices and personal protective equipment (PPE).
- HAZWOPER requirements are performance-oriented and are based on the risk an employer anticipates his/her employees will face. Each employer should review the requirements and choose the best way to apply them to specific emergency or clean-up operations.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Like the other requirements under HAZWOPER, the PPE requirements are performance-oriented. This means that the level of protection chosen, and the PPE used should be proportional to the risk anticipated for the task workers will do. OSHA provides the following recommendations, which are based on our recent experience with workplaces contaminated with anthrax spores. In most recent instances, exposure has generally resulted from contact with or dispersal of anthrax spores from a contaminated letter or package. As a result, many workers investigating suspected releases or cleaning up these types of releases may be able to respond in Modified Level C protection, outlined in Number 1 below. Terrorist releases of anthrax spores where there is no information about the potential source or dispersal method, or where the release is still occurring, will require that workers respond in higher levels of protection, as outlined in Numbers 2-3 below.

1. Modified Level C protection should be adequate during the investigation and clean-up of a known anthrax release where the agent was dispersed from a letter or package that can be easily bagged and there is no potential for splashing potentially contaminated materials. Modified Level C cannot be used if anthrax spores were dispersed using an aerosol-generating device, like a garden duster, or there is no information about how anthrax spores were released. Modified Level C should be consistent with the description in HAZWOPER Appendix B, but employees should wear a tight-fitting, full-face Powered Air-Purifying Respirator (PAPR) and skin protection with an integral hood and booties. Note: Selection of respiratory protection should be consistent with OSHA's Respiratory Protection Standard ([29 CFR 1910.134](#)) and take into account the agents used for decontamination. If organic vapor cartridges are used, then a cartridge change schedule should be implemented.
2. Level B protection should be adequate during response to or clean-up of a release where anthrax spores may have been dispersed with an aerosol-generating device but are no longer being released, or where there is a high potential for splashing potentially contaminated materials. Level B protection is a PPE ensemble that provides the highest level of respiratory protection, but a lesser level of skin protection than Level A. Level B protection should be consistent with the description in HAZWOPER Appendix B.
3. Level A should be adequate for response to or clean-up of a release that involves an unknown dispersal method. Level A protection should also be adequate during response to or clean-up of a release that involves an aerosol-generating device and the release is still occurring, or the release has stopped but there is no information about the duration of the release or the airborne concentrations of anthrax spores. Level A protection is a PPE ensemble that provides the greatest level of skin, respiratory, and eye protection. Level A protection should be consistent with the description in HAZWOPER Appendix B.
4. Personnel assisting in decontamination of emergency responders or clean-up personnel should be in PPE that is equivalent to one level below that required for the responder or clean-up personnel (e.g., if responder in Level A, then decontamination personnel in Level B).

YELLOW ZONE:

Workplaces Where Contamination with Anthrax Spores Is Possible



This zone is where workplace contamination is possible. Risk factors that should be considered in this zone include handling bulk mail, handling mail from facilities that are known to be contaminated, working near equipment such as high-speed processors/sorters that could aerosolize anthrax spores; workplaces in close proximity to other workplaces known to be contaminated; or workplaces that may be targets of bio-terrorists.

Engineering controls are the most effective controls an employer can use to protect employees. The Centers for Disease Controls and Prevention (CDC) provide a list of suggested engineering controls in [Recommendations for Protecting Workers from Exposure to Bacillus anthracis in Work Sites Where Mail Is Handled or Processed](#).

Prudent Work Practices:

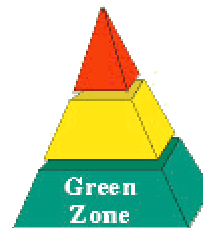
- Follow OSHA's recommendations for green zone workplaces for workers who open mail or respond to suspicious envelopes or packages.
- Develop strategies to limit the number of persons working at or near areas where airborne particles may be generated (e.g., mail-sorting machinery, places where mailbags are unloaded or emptied).
- Restrict the number of non-essential personnel (e.g., contractors, visitors, etc.) entering areas where airborne particles may be generated.
- Avoid practices that generate dust, such as dry sweeping, dusting, and using compressed air to clean machinery. Areas should be wet-cleaned or vacuumed with an industrial vacuum cleaner equipped with a high-efficiency particulate air (HEPA) filter. Conventional home or industrial vacuums should not be used since these vacuums may further disperse possible anthrax spores.
- Instruct employees to wash hands regularly with soap and water. At a minimum, hands should be washed when gloves are removed, before eating, and at the end of a shift.
- Establish procedures in the emergency plan for employees to report possible exposure and contact authorities:
 - Contact supervisor
 - Notify local police and local FBI
- Give workers information and training on:
 - Modes of anthrax transmission;
 - Signs and symptoms of anthrax infection;
 - Emergency procedures to deal with possible contamination;
 - Protective clothing to minimize skin exposure;
 - Care for abrasions that might provide an infection route.

Personal Protective Equipment (Voluntary)

- Impermeable gloves such as nitrile or vinyl.
- Properly fitted, NIOSH-certified filtering facepiece (N95 or greater). See Appendix D of OSHA's Respiratory Protection standard for information about the use of respirators when such use is voluntary. [29 CFR 1910.134 Appendix D](#)
- Respirators equipped with P-type filters in areas where oil mist from machinery is present should be considered to ensure filter effectiveness.

GREEN ZONE:

Workplaces Where Contamination with Anthrax Spores Is Unlikely



This zone covers the vast majority of workplaces in the United States. Since October 2001, anthrax spores have only been discovered in a very limited number of workplaces.

PRUDENT WORK PRACTICES

Establish procedures for safe handling of mail and packages. Employees should:

- Be on the lookout for suspicious envelopes or packages.
- NOT open suspicious mail!
- Open mail with a letter opener or another method that minimizes skin contact with the mail and is least likely to disturb contents.
- Open mail with a minimum amount of movement.
- Not blow into envelopes.
- Keep hands away from nose and mouth while opening mail.
- Turn off fans, portable heaters, and other equipment that may create air currents while opening mail.
- Wash hands after handling mail.

Train workers on characteristics of suspicious mail and how to respond. For guidance on identifying suspicious mail, see the Information Resources section below.

Establish procedures for handling mail that appears to contain a suspicious powder or other unusual substance. Employees should:

- Put the letter or package down on a stable surface and do not open or handle it further.
- Alert others nearby.
- Not try to clean up the substance.
- Not remove any items from the area.
- Leave the area and close the door gently.
- Contact their supervisor, designated responder, or other appropriate authority after evacuating.
- Wash hands with soap and water.

Designated responders or other appropriate authority will determine the need for further action.

PERSONAL PROTECTIVE EQUIPMENT (VOLUNTARY)

Employers may wish to consider providing nitrile or vinyl gloves to employees who request them.

APPENDIX G

**GENERIC APPROVAL OF COMMERCIAL
CHEMICAL PROTECTIVE EQUIPMENT FOR PROTECTION AGAINST
CHEMICAL WARFARE AGENT**

DACS-SF

1 May 2003

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Generic Approval of Commercial Chemical Protective Equipment

1. Reference:

a. DACS-SF memorandum dated 11 Apr 94, subject: Use of Commercially Available Chemical Protective Clothing.

b. DACS-SF memorandum dated 30 Dec 98, subject: Revised Policy for the Use of NIOSH-Certified Commercial Respirators with Chemical Agents.

c. DACS-SF memorandum dated 28 Feb 02, subject as above.

2. This memorandum supercedes reference “c.” Reference “c” presented a list of clothing and respirators approved by the U.S. Army Materiel Command Chemical Agent Safety and Health Policy Action Committee (CASHPAC), on behalf of the Director of Army Safety, for specific chemical agents and use scenarios and with specific limitations. The enclosure contains the updated list of approved commercial chemical protective equipment coupled with appropriate scenarios, limitations, and chemical agents.

3. Use of CASHPAC-approved chemical protective clothing/respirator approved for the specific agent and in the specific use scenario listed on the attached eliminates the need to use the CASHPAC approval process outlined in reference “a” and “b.” Note that under the following situations the CASHPAC approval process outlined in reference “a” and “b” must be used:

a. An installation/activity wants to use a commercial EPA Level A or B/C ensemble/respirator that has not been approved and listed by the CASHPAC.

b. A different use scenario is desired.

c. An installation/activity desires to use the commercial EPA Level A or B/C ensemble/respirator with chemical agent for which it has not been tested.

d. An installation/activity desires to use a commercial EPA Level A or B/C ensemble/respirator beyond its approved limitations.

DACS-SF

1 May 2003

SUBJECT: Generic Approval of Commercial Chemical Protective Equipment

4. An installation/activity planning to use CASHPAC approved/listed commercial chemical protective equipment will furnish a copy of the equipment selection decision logic (listing potential agent exposures and use scenarios) to DACS-SF for future reference. The installation/activity shall also maintain a copy of their decision logic for review by any Department of Army Pre-Operational Inspection Team and include it in applicable chemical warfare materiel safety submissions.

Encl

JAMES A. GIBSON
Senior Safety Manager
Office of the Director of Army Safety

DISTRIBUTION:

Deputy Assistant Secretary of the Army (Environment, Safety and Occupational Health), 110 Army Pentagon, Washington, DC 20310-0110

Project Manager for Chemical Stockpile Disposal, ATTN: SFAE-CD-SQ, Aberdeen Proving Ground, MD 21010-5401

Project Manager for Non-Stockpile Chemical Materiel, ATTN: SFAE-CD-N, Aberdeen Proving Ground, MD 21010-5401

Chief, National Guard Bureau, Army Aviation and Safety Directorate, Arlington Hall Readiness Center, ATTN: NGB-AVN-S, 111 South George Mason Drive, Arlington, VA 22204-1382

Commander, U.S. Army Materiel Command, ATTN: AMCSF, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

Commander, U.S. Army Soldier, Biological and Chemical Defense Command, ATTN: AMSBC-RA, Aberdeen Proving Ground, MD 21010-5423

Commander, U.S. Army Soldier, Biological and Chemical Defense Command, ATTN: AMSBC-SO, Aberdeen Proving Ground, MD 21010-5423

continued

Director, Edgewood Chemical Biological Center, ATTN: AMSCB-ODR-S, Aberdeen Proving Ground, MD 21010-5423

Commander, U.S. Forces Command, ATTN: AFPI-SO, Fort McPherson, GA 30330-6000

Commander, U.S. Army Corps of Engineers, ATTN: CESO-ZA, WASH DC 20314-1000

DACS-SF

1 May 2003

SUBJECT: Generic Approval of Commercial Chemical Protective Equipment

DISTRIBUTION, cont.

Commander, U.S. Army Training and Doctrine Command, ATTN: ATBO-S, Fort
Monroe, VA 23651-5000

Director, U.S. Army Nuclear and Chemical Agency, ATTN: ATNA-CM, 7150 Heller
Loop, Suite 101, Springfield, VA 22150-3198

Commander, U.S. Army Center for Health Promotion and Preventive Medicine,
ATTN: MCHB-TS-OFS, Aberdeen Proving Ground, MD 21010-5422

Commander, U.S. Army Test and Evaluation Command, 4501 Ford Avenue, Alexandria,
VA 22302-1458

Director, U.S. Army Technical Center for Explosives Safety, ATTN: JMCAC-ES,
McAlester, OK 74501

Manufacturer: Dupont and Dupont-licensed suppliers

Model: Tyvek “F”

Level: B/C

Agent(s): G-series, VX, HD, L

Use Scenario(s):

1. Intrusive excavation using, heavy machinery, hand tools, by hand, sifting equipment, etc.
2. Environmental sample collection such as soil, sludge, water, etc.
3. Decontamination of agent contaminated media. For example, soil, debris, etc.
4. Operation of a PDS or EPDS.
5. Assessment, packaging, unpackaging and removal of excavated items.
6. Well drilling/installation.
7. General site work such as, equipment maintenance, cylinder change-out, other routine tasks as defined in the applicable safety submission.
8. Disposal of HD ton containers.

Reuse: Not reusable if contaminated with vapor and/or liquid chemical agent. This is also a one-time use suit.

Limitations/Additional Requirements:

1. Must be removed immediately if contaminated with liquid chloroform/HD or GB and the wearer decontaminated within 30 minutes.
2. If workers encounter leaking CAIS they will immediately evacuate the area and don other approved chemical protective clothing.
3. CPU must be worn for HD operations.
4. May not be used if fire is expected (suit is not NFPA certified for flame resistance).
5. Have a heat stress plan developed, approved, and workers trained prior to use.
6. Suit must be thoroughly inspected before and during use for signs of wear.
7. Prior to use of suit, manufacturer shall provide validation of QA/QC batch testing of suit material swatches to ensure consistent materiel quality over time and between production lots.

Manufacturer: GEOMET (via Kappler)

Model: Geomet Responder CSM

Level: A/B

Agent(s): G-series, VX, HD, HN, L

Use Scenario(s):

1. Emergency response into an area in which an unplanned release of chemical agent has occurred.
2. Operation of a PDS/EPDS.
3. CAIRA operations such as, clean up of spills, air monitoring set up, first entry after engineering control failure, containment of open agent.
4. Demilitarization of CAIS (unpacking, segregating, storing, preparing, etc.).
5. Operations conducted in igloos or test chambers involving suspect chemical agent items.
6. Destruction/dismantling of contaminated buildings and equipment.
7. Isolation of leaking munitions.
8. Emergency back-up entries into IDLH areas.
9. Confined space entry into toxic/hazardous environments.
10. Routine first entry monitoring into outdoor or indoor agent storage areas/igloos.
11. Sampling and removal (manually or mechanically) of potentially contaminated soil and/or items from remediation sites.
12. Decontamination/treatment of soil samples.
13. Disposal of HD ton containers.

Reuse: Not reusable if contaminated with vapor and/or liquid chemical agent. Otherwise, if not contaminated, this is a limited use suit.

Limitations/Additional Requirements:

1. May not be used if fire is expected (suit is not NFPA certified for flame resistance) unless the silver over-shield is worn.
2. Have a heat stress plan developed, approved and workers trained prior to use.
3. Prior to use of suit, manufacturer shall provide validation of QA/QC batch testing of suit material swatches to ensure consistent materiel quality over time and between production lots.
4. Pass-through (if worn tethered) must be compatible with airline system.

Manufacturer: Trelleborg Industri

Model: TRELLCHEM HPS

Level: A

Agent(s): G-series, HD, L, VX

Use Scenario(s):

1. Working within a vapor containment structure (VCS).
2. Decontamination of a VCS.
3. CAIRA operations such as, clean up of spills, air monitoring set up, first entry after engineering control failure, containment of open agent.
4. Routine first entry monitoring into outdoor or indoor agent storage areas/igloos.
5. Operations conducted in igloos or test chambers involving suspect chemical agent items.
6. Destruction/dismantling of contaminated buildings and equipment.
7. Isolation of leaking munitions.
8. Emergency back-up entries into IDLH areas.
9. Confined space entry into toxic/hazardous environments.
10. Operation of the PDTDF (decontamination of interior and work conducted in agent environment).
11. Operation of the MAPS facility (removal of drill/cut box from the explosion containment chamber (ECC); decontamination of the ECC; opening munition overpack in process room; decontamination of the process room).
12. Operation of the solvated electron technology (SET™) with in a chemical agent test chamber.
13. Sampling and removal (manually or mechanically) of potentially contaminated soil and/or items from remediation sites.
14. Decontamination/treatment of soil samples.
15. Disposal of HD ton containers.

Reuse: Not reusable if contaminated with liquid agent; reusable if contaminated with vapor agent.

Limitations/Additional Requirements:

1. Have a heat stress plan developed, approved and workers trained prior to use.
2. Prior to use of suit, manufacturer shall provide validation of QA/QC batch testing of suit material swatches to ensure consistent materiel quality over time and between production lots.
3. Pass-through (if worn tethered) must be compatible with airline system.

Manufacturer: Trelleborg Industri

Model: TRELLECHEM TLU

Level: A

Agent(s): G-series, HD/L, VX

Use Scenario(s): CAIRA operations such as, clean up of spills, air monitoring set up, first entry after engineering control failure, containment of open agent.

Reuse: Not reusable if contaminated with vapor and/or liquid chemical agent. Otherwise, if not contaminated, this is a limited use suit.

Limitations/Additional Requirements:

1. May not be used if fire is expected (suit is not NFPA certified for flame resistance).
2. Have a heat stress plan developed, approved and workers trained prior to use.
3. Prior to use of suit, manufacturer shall provide validation of QA/QC batch testing of suit material swatches to ensure consistent materiel quality over time and between production lots.
4. Pass-through (if worn tethered) must be compatible with airline system.

Manufacturer: GEOMET

Model: Commercial STEPO

Level: A

Agent(s): G-series, HD/L, VX

Use Scenario(s): CAIRA operations such as, clean up of spills, air monitoring set up, first entry after engineering control failure, containment of open agent.

Reuse: Not reusable if contaminated with vapor and/or liquid chemical agent.

Limitations/Additional Requirements:

1. Have a heat stress plan developed, approved and workers trained prior to use.
2. Prior to use of suit, manufacturer shall provide validation of QA/QC batch testing of suit material swatches to ensure consistent materiel quality over time and between production lots.

Manufacturer: Trelleborg Industri

Model: TRELLCHEM HPS-TS

Level: B

Agent(s): G-series, HD/L, VX

Use Scenario(s):

1. Working within a vapor containment structure (VCS).
2. Decontamination of a VCS.
3. CAIRA operations such as, clean up of spills, air monitoring set up, first entry after engineering control failure, containment of open agent.
4. Routine first entry monitoring into outdoor or indoor agent storage areas/igloos.
5. Operations conducted in igloos or test chambers involving suspect chemical agent items.
6. Destruction/dismantling of contaminated buildings and equipment.
7. Isolation of leaking munitions.
8. Emergency back-up entries into IDLH areas.
9. Confined space entry into toxic/hazardous environments.
10. Operation of the PDTDF (decontamination of interior and work conducted in agent environment).
11. Operation of the MAPS facility (removal of drill/cut box from the explosion containment chamber (ECC); decontamination of the ECC; opening munition overpack in process room; decontamination of the process room).
12. Operation of the solvated electron technology (SET™) with in a chemical agent test chamber.
13. Sampling and removal of potentially contaminated soil and/or items from remediation sites.

Reuse: Not reusable if contaminated with liquid agent; reusable if contaminated with vapor agent.

Limitations/Additional Requirements:

1. Prior to use of suit, manufacturer shall provide validation of QA/QC batch testing of suit material swatches to ensure consistent materiel quality over time and between production lots.

Manufacturer: Kappler®

Model: Kappler® Coverall Style 41250 FV

Level: N/A

Agent(s): GB, HD, L, VX

Use Scenario(s):

1. Routine disposal of the industrial and warfare chemicals found in CAIS sets.

Reuse: Not reusable if contaminated with liquid or vapor agent.

Limitations/Additional Requirements:

1. The Kappler® Coverall is approved for use as a replacement for the Army Level B apron.
2. Prior to use of suit, manufacturer shall provide validation of QA/QC batch testing of suit material swatches to ensure consistent materiel quality over time and between production lots.
3. Must have a complete inspection program in place and employed to ensure that damaged coveralls are not reused.

Manufacturer: North

Model: North 7600-8A NIOSH-Certified Full Facepiece Air-Purifying Respirator with North 7583/P100 Organic Vapors/Acid Gases Cartridge/Filter

Level: N/A

Agent(s): Specific chemical agents listed in AR 50-6.

Use Scenario(s):

1. Added protection in chemical agent laboratory operations when chemical agent is inside a certified chemical agent laboratory ventilation hood.
2. Emergency-escape from a chemical agent laboratory.

Reuse: Respirators and cartridges that have been exposed to chemical agents will be decontaminated, monitored, and disposed of.

Limitations/Additional Requirements:

1. Near Real Time (NRT) monitoring must be conducted to ensure agent levels do not exceed the Maximum Use Concentration (MUC) for the specific agent involved. The MUC is the assigned protection factor of the respirator (50) multiplied times the Airborne Exposure Limit (AEL) for the agent. The MUC for mustard and Lewisite will not exceed 0.003 mg/m³.
2. The user's Respiratory Protection Program will meet the requirements of 29 CFR 1910.134, to include establishing filter/canister change-out schedules.
3. Additional personal protective clothing and equipment will be adequate for the work being performed.

Manufacturer: North

Model: North 7600 Series NIOSH-Certified Full Facepiece Air-Purifying Respirator with North 7583/P100 Organic Vapors/Acid Gases Cartridge/Filter

Level: N/A

Agent(s): Specific chemical agents listed in AR 50-6.

Use Scenario(s):

1. Environmental sampling.
2. Excavation into anomalies.
3. Operations where personnel are responsible for decontaminating personnel and equipment.
4. Emergency escape for personnel working outside the exclusion zone but within the No Significant Effects zone, in the event the near real time (NRT) monitoring devices alarm.
5. Emergency escape from chemical area.
6. Maintenance operations.
7. Industrial chemical operations in support of MMD-1 operations.
8. Processing of munitions/container carcasses already processed in the MMD-1 Process Trailer.
9. Agent treatment process liquid and/or vapor sampling filter unit, and gas reactor carbon replacement in support of MMD-1 operations.

Reuse: Respirators and cartridges that have been exposed to chemical agents will be decontaminated, monitored, and disposed of.

Limitations/Additional Requirements:

1. Near Real Time (NRT) monitoring must be conducted to ensure agent levels do not exceed the Maximum Use Concentration (MUC) for the specific agent involved. The MUC is the assigned protection factor of the respirator (50) multiplied times the Airborne Exposure Limit (AEL) for the agent. The MUC for mustard and Lewisite will not exceed 0.003 mg/m³.
2. The user's Respiratory Protection Program will meet the requirements of 29 CFR 1910.134, to include establishing filter/canister change-out schedules.
3. Additional personal protective clothing and equipment will be adequate for the work being performed.

Manufacturer: MSA

Model: MSA Ultra-Twin NIOSH-Certified Full Facepiece Air-Purifying Respirator with MSA GME Super Cartridges/P100 Filters

Level: N/A

Agent(s): Specific chemical agents listed in AR 50-6.

Use Scenario(s):

1. Environmental sampling.
2. Excavation into anomalies.
3. Operations where personnel are responsible for decontaminating personnel and equipment.
4. Emergency escape for personnel working outside the exclusion zone but within the No Significant Effects zone, in the event the near real time (NRT) monitoring devices alarm.
5. Emergency escape from chemical area.
6. Maintenance operations.

Reuse: Respirators and cartridges that have been exposed to chemical agents will be decontaminated, monitored, and disposed of.

Limitations/Additional Requirements:

1. NRT monitoring must be conducted to ensure agent levels do not exceed the Maximum Use Concentration (MUC) for the specific agent involved. The MUC is the assigned protection factor of the respirator (50) multiplied times the Airborne Exposure Limit (AEL) for the agent. The MUC for mustard and Lewisite will not exceed 0.003 mg/m³.
2. The user's Respiratory Protection Program will meet the requirements of 29 CFR 1910.134, to include establishing filter/canister change-out schedules.
3. Additional personal protective clothing and equipment will be adequate for the work being performed.

Manufacturer: MSA

Model: MSA Advantage 1000 NIOSH-Certified Full Facepiece Air-Purifying Respirator with MSA GME Super Cartridges/P100 Filters

Level: N/A

Agent(s): Specific chemical agents listed in AR 50-6.

Use Scenario(s):

1. Industrial chemical operations where there is a potential for chemical agent exposure.
2. Operation of Rapid Response System (RRS).
3. Operation of the Emergency Personnel Decontamination Station (EPDS).
4. Maintenance and housekeeping operations.
5. Emergency escape from chemical area.
6. Industrial chemical operations in support of MMD-1 operations.
7. Processing of munitions/container carcasses already processed in the MMD-1 Process Trailer.
8. Agent treatment process liquid and/or vapor sampling filter unit, and gas reactor carbon replacement in support of MMD-1 operations.

Reuse: Respirators and cartridges that have been exposed to chemical agents will be decontaminated, monitored, and disposed of.

Limitations/Additional Requirements:

1. NRT monitoring must be conducted to ensure agent levels do not exceed the Maximum Use Concentration (MUC) for the specific agent involved. The MUC is the assigned protection factor of the respirator (50) multiplied times the Airborne Exposure Limit (AEL) for the agent. The MUC for mustard and Lewisite will not exceed 0.003 mg/m³.
2. The user's Respiratory Protection Program will meet the requirements of 29 CFR 1910.134, to include establishing filter/canister change-out schedules.
3. Additional personal protective clothing and equipment will be adequate for the work being performed.

APPENDIX H

TOXIC INDUSTRIAL CHEMICALS

Table. TICs Listed by Hazard Index (Ref. 65a)

High	Medium	Low
Ammonia	Acetone cyanohydrin	Allyl isothiocyanate
Arsine	Acrolein	Arsenic trichloride
Boron trichloride	Acrylonitrile	Bromine
Boron trifluoride	Allyl alcohol	Bromine chloride
Carbon disulfide	Allylamine	Bromine pentafluoride
Chlorine	Allyl chlorocarbonate	Bromine trifluoride
Diborane	Boron tribromide	Carbonyl fluoride
Ethylene oxide	Carbon monoxide	Chlorine pentafluoride
Fluorine	Carbonyl sulfide	Chlorine trifluoride
Formaldehyde	Chloroacetone	Chloroacetaldehyde
Hydrogen bromide	Chloroacetonitrile	Chloroacetyl chloride
Hydrogen chloride	Chlorosulfonic acid	Crotonaldehyde
Hydrogen cyanide	Diketene	Cyanogen chloride
Hydrogen fluoride	1,2-Dimethylhydrazine	Dimethyl sulfate
Hydrogen sulfide	Ethylene dibromide 4,4'	Diphenylmethane-4,4'-diisocyanate
Nitric acid, fuming	Hydrogen selenide	Ethyl chloroformate
Phosgene	Methanesulfonyl chloride	Ethyl chlorothioformate
Phosphorus trichloride	Methyl bromide	Ethyl phosphonothioic dichloride
Sulfur dioxide	Methyl chloroformate	Ethyl phosphonic dichloride
Sulfuric acid	Methyl chlorosilane	Ethyleneimine
Tungsten hexafluoride	Methyl hydrazine	Hexachlorocyclopentadiene
	Methyl isocyanate	Hydrogen iodide
	Methyl mercaptan	Iron pentacarbonyl
	Nitrogen dioxide	Isobutyl chloroformate
	Phosphine	Isopropyl chloroformate
	Phosphorus oxychloride	Isopropyl isocyanate
	Phosphorus pentafluoride	n-Butyl chloroformate
	Selenium hexafluoride	n-Butyl isocyanate
	Silicon tetrafluoride	Nitric oxide
	Stibine	n-Propyl chloroformate
	Sulfur trioxide	Parathion
	Sulfuryl chloride	Perchloromethyl mercaptan
	Sulfuryl fluoride	sec-Butyl chloroformate
	Tellurium hexafluoride	Tert-Butyl isocyanate
	n-Octyl mercaptan	Tetraethyl lead
	Titanium tetrachloride	Tetraethyl pyrophosphate
	Trichloroacetyl chloride	Tetramethyl lead
	Trifluoroacetyl chloride	Toluene diisocyanate
		Toluene 2,6-diisocyanate

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