# *Managing Hazardous Materials Incidents*

*Volume I*
*Volume II*
*Volume III*

*Including ToxFAQs™*

## A Planning Guide for the Management of Contaminated Patients


**U.S. Department Of Health And Human Services**
**Public Health Service**
**Agency for Toxic Substances and Disease Registry**

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

# MANAGING HAZARDOUS MATERIALS INCIDENTS

## A Three Volume Series

**Agency for Toxic Substances and Disease Registry** **March 2001**

**Under the authority of the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Agency for Toxic Substances and Disease Registry (ATSDR) works to prevent or mitigate adverse human health effects and diminished quality of life resulting from exposure to hazardous substances in the environment. In pursuit of this mission, Managing Hazardous Materials Incidents, Volume I , II, & III, and the training video have been developed to provide emergency medical services (EMS) personnel and hospital emergency departments (EDs) with the necessary guidance to plan for, and improve their ability to respond to, incidents that involve human exposure to hazardous materials. The guidelines inform emergency personnel how to appropriately decontaminate, treat, and recommend follow-up care to exposed persons, as well as take measures to protect themselves.**

**HIGHLIGHTS: ATSDR's Managing Hazardous Materials Incidents is a three volume set (with video) comprised of recommendations for on-scene (prehospital), and hospital medical management of patients exposed during a hazardous materials incident. Volume I - Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients and Volume II - Hospital Emergency Departments: A Planning Guide for the Management of Contaminated Patients are planning guides to assist first responders and hospital emergency department personnel in planning for incidents that involve hazardous materials. Volume III - Medical Management Guidelines for Acute Chemical Exposures is a guide for health care professionals who treat persons who have been exposed to hazardous materials. Community Challenge: Hazardous Materials Response and the Emergency Medical System - is a training video for Volumes I & II (50 minutes total; 25 minutes for each volume).**

**MANAGING HAZARDOUS MATERIALS INCIDENTS:**
**(a three-volume series plus a training video)**

| | |
|---|---|
| **Volume I** | **Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients.** |
| **Volume II** | **Hospital Emergency Departments: A Planning Guide for the Management of Contaminated Patients.** |
| **Volume III** | **Medical Management Guidelines for Acute Chemical Exposures.** |
| **Video** | **Community Challenge: Hazardous Materials Response and the Emergency Medical System - a training video for Volumes I & II (50 minutes total; 25 minutes for each volume).** |

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service**
**Agency for Toxic Substances and Disease Registry**

**The ATSDR Internet address is < http://www.atsdr.cdc.gov >**

**Volume III of the Managing Hazardous Materials Incidents contains Medical Management Guidelines for 40 hazardous substances. Each Medical Management Guideline is divided into five easy to use sections:**

- ***General Information*** **(synonyms, appearance, routes of exposure, potential for secondary contamination, sources/uses, physical properties, and exposure standards).**
- ***Health effects*** **(organ systems affected by acute exposure, potential sequelae, and chronic effects).**
- ***Pre-hospital management*** **(personal protection, decontamination, support, triage, and transportation, organized by hot zone, decontamination zone, and support zone).**
- ***Emergency department management*** **(management and treatment)**
- ***Patient information sheet*** **(information of exposure, potential effects, and follow-up instructions).**

**The general hazardous substances (35)**

| | | |
|---|---|---|
| **Acrylonitrile** | **Formaldehyde** | **Phosgene** |
| **Ammonia** | **Gasoline** | **Phosphine** |
| **Aniline** | **Hydrogen Chloride** | **Sodium Hydroxide** |
| **Arsenic Trioxide** | **Hydrogen Cyanide** | **Sulfur Dioxide** |
| **Arsine** | **Hydrogen Fluoride** | **Tetrachloroethylene** |
| **Benzene** | **Hydrogen Peroxide** | **Toluene** |
| **Butadiene** | **Hydrogen Sulfide** | **Toluene Diisocyanate** |
| **Chlordane** | **Methyl Bromide** | **Trichloroethane** |
| **Chlorine** | **Methylene Chloride** | **Trichloroethylene** |
| **Elemental Mercury** | **Nitrogen Oxides** | **Vinyl Chloride** |
| **Ethylene Glycol** | **Parathion** | **Xylene** |
| **Ethylene Oxide** | **Phenol** | **Unidentified Chemical** |

**The DOD-related hazardous substances (5)**

| | |
|---|---|
| **Phosgene Oxime** | **Blister Agents: Lewisite, Mustard - Lewisite Mixture (L, HL)** |
| **Nerve Agents (GA, GB, GD, VX)** | **Blister Agents: Nitrogen Mustard (HN-1, HN-2, HN-3)** |
| | **Blister Agents: Sulfur Mustard (H, HD, HT)** |

**PEDIATRIC ISSUES: Children's unique physiology and behavior can influence the extent of their exposure, and they may differ in their susceptibility to hazardous chemicals. As a result of ATSDR's Childhood Health Initiative, the three volume set has been updated to include any pediatric specific information/data on each substance listed above.**

**INTENDED AUDIENCE: HAZMAT Teams, Emergency Medical Personnel, Hospital Emergency Department Personnel, DHHS, DOD, DOE, FBI, FEMA, U.S. Marine Corps Chemical and Biological Incident Response Force (CBIRF), U.S. Uniformed Services University, City and County Emergency Management Agencies, International/Foreign Agencies and Organizations.**

**Where can I get more information?** For more information about the Managaing Hazardous Mateerial Incidents publications including the Medical Management Guidlines contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop E-57, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 404-639-6359. The ATSDR Internet address is < http://www.atsdr.cdc.gov >.

# *Managing Hazardous Materials Incidents*

## Volume I
***(revised)***

## Emergency Medical Services

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## A Planning Guide for the Management of Contaminated Patients


**U.S. Department Of Health And Human Services**
**Public Health Service**
**Agency for Toxic Substances and Disease Registry**

# *Managing Hazardous Materials Incidents*

***Volume I***
***(Revised)***

## Emergency Medical Services:

## A Planning Guide for the Management of Contaminated Patients

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**
Public Health Service
Agency for Toxic Substances and Disease Registry

The Agency for Toxic Substances and Disease Registry (ATSDR) has produced a three-volume series entitled Managing Hazardous Material Incidents. The series is designed to help emergency response and health care professionals plan for and respond to hazardous material emergencies.

| | |
|---|---|
| Volume I | Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients |
| Volume II | Hospital Emergency Departments: A Planning Guide for the Management of Contaminated Patients |
| Volume III | Medical Management Guidelines for Acute Chemical Exposures |

Volumes I and II are planning guides to assist first responders and hospital emergency department personnel in planning for incidents that involve hazardous materials.

Volume III is a guide for health care professionals who treat persons who have been exposed to hazardous materials.

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# Volume I - Table of Contents

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[1] The above reviewers were recommended by the organizations listed but do not necessarily represent them.

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# Introduction

The presence of hazardous materials or toxic chemicals at an incident location or other emergency situation adds a new dimension of risk to those handling and treating casualties. The fundamental difference between a hazardous materials incident and other emergencies is the potential for acute risk from contamination to both patient and responder. In some cases, traditional practices must be altered to avoid compounding a critical situation.

Emergency medical services (EMS) must protect their personnel on site and en route to the hospital, and other people within the hospital, while providing the best care for the chemically contaminated patient. This guide is intended to help emergency medical services plan for incidents that involve hazardous chemicals and improve their ability to respond to these incidents.

To ensure appropriate and timely patient care, as well as optimal response protection, emergency personnel must understand decontamination procedures and personal protective equipment, neither of which are routinely covered in the course of their professional training. They should also be aware of community resources that could be called upon to assist with an emergency response.

Current training curricula for emergency room physicians and nurses and emergency medical technicians (EMTs) often do not adequately prepare these professionals to manage the contaminated individual or to decontaminate patients exposed to toxic substances. Accurate, specific, and concise guidance is needed to describe appropriate procedures to be followed by emergency medical personnel to safely care for a patient(s), as well as to protect responders, equipment, hospital personnel, and others from risk of secondary exposure. In response to this need, the Agency for Toxic Substances and Disease Registry (ATSDR) contracted for the production of a three-volume series entitled *Managing Hazardous Materials Incidents:* I. Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients; II. Hospital Emergency Departments: A Planning Guide for the Management of Contaminated Patients; and III. Medical Management Guidelines for Acute Chemical Exposures. The second document is designed for use by emergency department personnel to minimize their risks of exposure within the emergency department, and to provide for the safe and effective treatment of chemically contaminated patients.

This volume, written for emergency response personnel, is designed to familiarize readers with the terminology, concepts, and key operational considerations that affect the proper management of incidents of chemical contamination. It is designed not only to present uniform guidance for the emergency care of chemically contaminated patients, but also to provide basic information necessary to comprehensive planning and implementation of EMS strategies. It is intended to illustrate the characteristics of hazardous materials (hazmat) incidents that compel emergency response personnel to modify their preparations and response procedures.

Not all hospitals and community emergency response systems are prepared to respond to a hazardous chemical incident to the same degree. This document may be used to assess the capabilities of EMS with respect to potential community hazards and to develop response plans using national and community-specific resources. Employee safety and training are also key factors in effective management of medical emergencies. This document is intended to provide source material for developing local training and safety protocols.

Section I, *Systems Approach to Planning,* introduces guidelines for emergency preparedness and prehospital response planning. Government and private planning activities are outlined, including those established under Title III of the Superfund Amendments and Reauthorization Act (SARA); the National Response Team; the Community Awareness Emergency Response (CAER) program; and the Chemical Emergency Preparedness Program (CEPP). This chapter discusses the need for hazard identification and risk analysis pertaining to hazardous materials located in a community or transported through it. Recommended training for EMS personnel is also included.

Section II, *Emergency Medical Services Response to Hazardous Materials Incidents,* outlines general principles for hazard recognition, chemical exposure, and personal protective equipment. In addition, the hazard recognition section presents generalized guidance for determining whether a given situation constitutes a hazardous materials incident, and details various hazardous materials classification systems. This section provides basic toxicological and chemical terminology that emergency personnel need to understand to effectively conduct patient assessments. It also presents an outline of personal protective equipment, such as respiratory devices and protective clothing.

Section III, *Response and Patient Management,* includes guidelines for EMS preparation and response to a potential hazardous materials incident. This chapter also discusses patient assessment, clinical management, and decontamination guidelines.

This guidance document is intended to improve the safety of responders as well as of patients. It is not, however, all-encompassing, nor can it be regarded as a substitute for comprehensive instruction and training for hazardous materials incidents. Supplemental material that is vital to successful response to hazardous materials contamination is cited within the document. These materials should be carefully reviewed before preparing any strategic plans or conducting training exercises on this topic. Also, this document generally does not cover issues associated with weapons of mass destruction (WMD), although some of the information presented is pertinent to these situations as well. Other ATSDR documents specifically address WMD concerns.


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# Section I. Systems Approach To Planning

## The Role of EMS in a Systems Approach to Planning

The potential for hazardous materials incidents exists almost everywhere. While infrequent, chemical incidents are capable of endangering the health of the individuals involved and the emergency personnel directed to assist them. People who have been seriously injured by a hazardous material have a greater chance of recovery without complications when appropriate emergency treatment is provided by trained prehospital Emergency Medical Service (EMS) personnel at the scene, and when the patient is transported to a facility having the most appropriate personnel and technical resources to manage his or her care. This requires an integrated emergency medical response. However, many local governments, private businesses, and hospitals do not have a tested hazardous materials response plan in place that integrates all of the responding agencies and personnel. This has resulted in several problems:

- Incidents have been poorly managed on site by first responders.
- Communication channels between the private and public sectors, or among public responders, have not been clearly identified and formalized.
- The medical community has not been firmly integrated into many response systems and may not be prepared to treat multiple casualties resulting from a serious hazardous materials incident.

EMS agencies are a crucial link in the community response system for emergency preparedness planning. EMS personnel are often the first to arrive at an incident scene and must assess the nature and extent of the hazard as well as attend to the immediate needs of victims, including initial treatment of people who may have been chemically contaminated. For effective coordination and communication, hospitals, EMS agencies, and other response agencies must participate jointly in local meetings involving hazmat planning, incident management, and protocol review.

EMS agencies must acknowledge their role and responsibility as a component of the communitywide emergency response system. Administrators should familiarize themselves with the contingency plans of other participants, such as fire, police, and health departments and area hospitals, and understand what services are expected from each participant. Optimally, EMS staff should be represented on planning committees that develop and periodically review these contingency plans.

A common characteristic of the successful management of chemical incidents is adequate contingency planning. Local emergency planning committees are mandated under federal law to identify high-risk locations and ensure adequate response planning and training. Planning requires the involvement of an array of community institutions, including fire, EMS and police departments, community hospitals, other health facilities, and the regional Poison Control Center.

## Prehospital Response Planning

To ensure an effective and safe response to a hazardous materials accident, an EMS agency must develop a written response plan which becomes an integral part of the local community response plan. This agency plan should include important definitions, incident command practices to follow,

operational policies and procedures, safety practices, medical practices, and transportation guidelines. The plan should be developed in collaboration with other response agencies and hospitals, and reviewed annually. Training sessions based on the plan should be given on a regular basis to all agency personnel. Various types of disaster drills should be held each year to evaluate the effectiveness of the plan, as well as of the training sessions. The plan should be revised, and further training offered, based on feedback from its use.

## The Spectrum of Hazardous Materials Incidents

Local and state EMS agencies should be able to participate in the response to a range of hazmat incidents from the individual level, through the multi-casualty, to the mass-casualty level. The hospital(s) and emergency medical responders are key components of the local response system. Planning should integrate hospital(s) and EMS personnel, equipment, and supply needs into state and local hazmat plans. In turn, the hospital must be familiar with these plans and know how to use them if it is involved in an incident that overwhelms its capabilities.

- **Individual patient:** A single individual is contaminated and must be transported to an emergency department:
  - Can occur in the workplace, in a public place, or at home.
  - May pose a problem in rural areas with small hospitals, or where there are low levels of hazmat skills and experience among EMTs.
- **Multi-casualty:** This situation is usually limited to a single location:
  - Involves normal systems of transportation.
  - Patients are usually treated at the same level facility as a single emergency response, but the demand on all systems is much greater.
- **Mass-casualty:** Disrupts a large segment of the community:
  - Involves several locations.
  - Involves additional units to the normal responders (mutual aid); such units may not be part of the local EMS system, and these units may not know how the system works.
  - Involves long-range mutual aid; normal systems of transportation (ambulances) are inadequate or disrupted.
  - Patients may be treated locally at different facilities that provide various levels of care, or even outside of the area altogether.
  - May be an intentional criminal act with secondary harmful devices present.

While transportation incidents attract larger media attention, statistics show that almost 75 percent of acute hazardous materials events, excluding fuel spills, occur in the fixed locations where the chemicals are used or stored. In addition, events resulting in death and injury occur almost 1.5 times as often in fixed locations as in transit.

Hazardous material incidents range from small releases at a factory site to rapidly expanding events that may endanger a community. Regardless of the size or location of an incident, its successful management depends on preplanning. This preplanning often requires coordination among local, state, and federal agencies; industries; medical personnel; military hospitals; the Health Department; the regional Poison Control Center, as well as those in the community who use and maintain stocks of potentially hazardous materials. Contributions to hazardous materials planning come from a variety of sources. These include regulations from the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), state and local planning committees established under Title III of the Superfund Amendments and Reauthorization Act (SARA), state EMS agencies, and federal agencies.

## SARA Title III

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) provides for an infrastructure in states and local communities to plan for effective response to hazardous materials emergencies. The legislation also provides for public access to information on the presence and releases of specified hazardous chemicals in communities.

Title III, The Emergency Planning and Community Right-to-Know Act of 1986, requires that each state establish a State Emergency Response Commission (SERC), consisting of members with technical expertise in emergency response, environmental and natural resources, public health, occupational safety, media, and transportation. The SERC is responsible for establishing local emergency planning districts (usually on a county level), appointing and overseeing local emergency planning committees (LEPCs), establishing procedures for handling public requests for information, and reviewing LEPC emergency plans.

SARA Title III requires that the local committees include, at a minimum, representatives from the following groups: state and local officials, law enforcement, civil defense, firefighters, environmental, hospital, media, first aid, health, transportation, and facility owners or operators subject to the emergency planning requirements. LEPCs were primarily responsible for preparing a comprehensive emergency response plan for their districts by October 1988, using information about the presence of potentially hazardous chemicals reported by businesses and other facilities under Title III. LEPCs were also charged with making information on hazardous chemicals available to the public.

As part of the planning process, each LEPC must evaluate available resources for developing, implementing, and exercising its plan. The plan must include:

- Identification of facilities subject to planning provisions under Title III
- Identification of transportation routes for extremely hazardous substances
- Identification of risk-related facilities
- Methods and procedures for response
- Designated community and facility coordinators
- Procedures for public notification

- Methods for determining release occurrence and the area affected
- Description of emergency equipment and facilities, and those responsible for them
- Evacuation plans and training programs

Under Title III s planning provisions, EPA was mandated by Congress to establish a list of chemicals to help focus local emergency planning activities. In April 1987, EPA listed 406 Extremely Hazardous Substances (EHSs) and established a Threshold Planning Quantity (TPQ) for each. Any business or facility that contains one or more of these EHSs in an amount equal to or greater than its respective TPQ is required to notify the SERC and LEPC. These facilities must also appoint a coordinator to work with the LEPC for specific inclusion of that facility in the local plan.

Representative facilities covered under the planning provisions include not only major chemical manufacturing facilities but a wide variety of chemical users, such as farmers, dry cleaners, and other service-related businesses. Exemptions under this provision apply only to vessels (ship/boat), federal facilities, and transportation operations. Storage incidental to transportation is exempt provided that the EHSs are still moving under active shipping papers and have not reached the final consignee.

Accidental releases of EHSs and other hazardous substances identified in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) must be reported to the LEPC and SERC. This requirement ensures immediate notification of local response personnel. Other provisions of Title III provide further information on the presence, storage, and emissions of hazardous and toxic chemicals. These data further assist the LEPC in obtaining a comprehensive picture of chemical risk in the local district.

Emergency medical personnel can be better prepared to respond to incidents that involve contaminated victims by actively participating in the LEPC planning process. Title III provides for the submission of information on hazardous and toxic chemicals as presented above. In addition, Title III contains a specific provision requiring facility owners or operators to disclose the chemical identity of substances for which companies have made trade secret claims. Access to chemical identities assists health professionals, physicians, and nurses in obtaining further information for diagnostic and treatment recommendations during emergencies, and for prevention and treatment measures during nonemergencies.

## The State Emergency Medical Services (EMS) Agency

Planning for hazardous materials incidents should include the appropriate linkage to the state EMS agency. The state agencies are responsible for overseeing a network of local EMS units, and thus are an essential part of the planning process. This body is often part of the SERC.

The duties of these agencies vary from state to state. However, EMS agencies are usually responsible for medical management of civilians and injured first responders. EMS agencies must develop medical mutual aid agreements between counties and establish procedures for distribution of casualties between hospitals. In addition, EMS agencies should maintain an inventory of disaster medical supplies. EMS agencies should also develop and maintain communications protocols for onsite activities

(e.g., between receiving hospitals and the base hospital, between base hospitals and ambulances, between all hospitals and the regional Poison Control Center). Further, EMS agencies must work with local and state officials in designating field casualty decontamination and collection points for a major disaster, and in arranging for the acquisition and distribution of additional equipment, supplies, and pharmaceuticals.

Suggested planning activities include:

- **Incident Management:** Establish with fire and police departments a unified command approach to mitigating a hazmat or Weapons of Mass Destruction (WMD) incident.

- **Triage:** Outline triage procedures to be utilized in prioritizing decontamination and transport of multiple patients.

- **Decontamination:** Institute a regional standard for performing decontamination of ambulatory and nonambulatory patients, in coordination with the fire department, hazmat team(s), and hospitals. Planning should also address how to handle children, pregnant women, the elderly and the infirm, as well as large numbers of patients (mass decontamination).

- **Medical Management Protocols:** The literature on the clinical management of hazardous materials exposures is sometimes inconsistent in its recommendations. Provisions should be made in the plan for obtaining field and hospital medical management information from experienced physicians. For example, the regional Poison Control Center can provide decontamination and medical management protocols via fax, e-mail, or telephone to all receiving hospitals, and through the base hospital or via cellular telephone to EMTs in the field. Planning should address antidote utilization and the rapid acquisition of additional supplies and pharmaceuticals, if needed. Volume III in this series, *Medical Management Guidelines for Acute Chemical Exposures,* contains useful emergency care recommendations for prehospital and hospital personnel.

- **Patient Destination:** Hospital emergency departments are able to provide supportive care. In some cases, however, it may be more appropriate to take the patient to a hospital that has expertise in handling certain kinds of poison exposures or injuries. The plan should include directions for obtaining this information. One option is to contact the regional Poison Control Center or the base hospital. The Poison Center will often know which hospitals are best prepared to handle exposures to which substances.

- **Coordination with Burn Centers, Trauma Centers, Hyperbaric Chamber Facilities, Health Department(s), and Other Specialty Centers:** Provisions should be made to alert and coordinate patient destination with various specialty care centers.

- **Mental Health:** Identify mental health resources, such as critical incident stress debriefing teams, to assist with meeting the mental health needs of patients, response personnel, and the general public.

- **Documentation:** Identify the required incident documentation that must be completed during and after the hazardous materials incident.

- **Media Relations:** Appoint an individual who will handle all media requests for information.

## Federal Emergency Response Activities

Contingency planning is essential to the successful implementation of any system designed to manage chemically contaminated patients and to promptly contain the hazard itself. Contingency plans require a coordinated community response that may also involve state and federal agencies. Preplanning and coordination of services are equally critical at the national level. The federal government established a National Contingency Plan (NCP) to promote coordination of resources and services of federal and state response systems. To oversee this plan, a National Response Team (NRT) and a National Response Center, a network of Regional Response Teams (RRTs), and a group of On-Scene Coordinators (OSCs) have been established. In addition, with passage of the Nunn-Lugar-Domenici Anti-Terrorism Bill in 1996, the U.S. Public Health Service developed a series of strategically placed Metropolitan Medical Response Teams (NMRTs) to respond in the event of Nuclear, Biological, or Chemical (NBC) terrorism. These multidisciplinary teams, consisting of police, hazmat, EMS, and hospital personnel, are specially trained and equipped to respond to serious hazmat incidents as well as to NBC-related situations.

The *Hazardous Materials Emergency Planning Guide*, referred to as NRT-1, provides guidance to help local communities prepare for potential hazardous materials incidents. NRT-1 can be used by local communities developing their own plans, as well as by LEPCs formed in accordance with the Emergency Planning and Community Right-to-Know Act of 1986 (SARA Title III).

The objectives of the *Hazardous Materials Emergency Planning Guide* are to:

- Focus communities on emergency preparedness and response.
- Provide communities with information that can be used to organize the emergency planning task.
- Furnish criteria for risk and hazard assessments, and to assist communities in determining whether a hazardous materials incident plan is needed in addition to the districtwide plan developed by the LEPC.
- Help LEPCs and individual communities prepare a plan that is appropriate for their needs and consistent with their capabilities.
- Provide a method for revising, testing, and maintaining community emergency plans.

NRT-1 is published by the National Response Team, and was developed cooperatively by its federal member agencies, including the Department of Defense, Department of the Interior, Department of Transportation, U.S. Coast Guard, Environmental Protection Agency (EPA), Department of Commerce (National Oceanic and Atmospheric Administration [NOAA]), Federal Emergency Management Agency (FEMA), Department of State, Department of Agriculture, Department of Health and Human Services (Agency for Toxic Substances and Disease Registry [ATSDR]), Department of Justice, General Services Administration (GSA), Department of the Treasury, Department of Labor (Occupational Safety and Health Administration [OSHA]), Nuclear Regulatory Commission (NRC), and the Department of Energy (DOE). NRT-1 represents a concerted effort by federal agencies to consolidate their general hazardous materials planning guidance into an integrated federal document.

NRT-1 states that an emergency plan must include response procedures of facilities and local emergency and medical personnel, as well as a description of emergency equipment and facilities in the community. It also recommends that hospital, emergency medical service, and health department personnel be included as members of an emergency planning team. As previously mentioned, SARA Title III requires medical, hospital, and first aid personnel to be members of the local emergency planning committee. NRT-1 describes relevant publications that provide specific operational guidance to emergency responders, such as the DOT s *North American Emergency Response Guidebook (NAERG),* which provides guidance for firefighters, police, and other emergency services personnel to help them protect themselves and the public during the initial minutes immediately following a hazardous materials incident.

In addition, the document provides information on the Chemical Manufacturers Association s (CMA) Community Awareness Emergency Response (CAER) and Chemical Transportation Emergency Center (CHEMTREC) programs. The CAER program encourages local chemical manufacturing facilities to inform area residents, public officials, and emergency response organizations about industry operations and to integrate their onsite emergency response plans with the planning efforts of the local community. In some areas of the country, the chemical industry has established physician networks to encourage better dialogue between company physicians and local health authorities. CAER has outlined specific steps for industrial plants:

- Review the plant s emergency plan
- Improve employee awareness and training
- Prepare a community relations plan
- Inventory the status of local emergency planning
- Develop a briefing paper
- Prepare a list of initial contacts
- Meet with initial contacts and identify key officials
- Establish a coordinating group
- Begin implementation steps

On the federal level, EPA and FEMA provide technical assistance and guidance to local and state planners through the SARA Title III program.

The NRT-1 document also recommends that contingency plans include standard operating procedures for entering and leaving sites, accountability for personnel entering and leaving sites, decontamination procedures, recommended safety and health equipment, and personal safety precautions. The document suggests that emergency plans include a list of emergency response equipment appropriate to the various degrees of hazard based on EPA s four levels of protection (Levels A through D; see Section II). Further, it recommends that the list include the type of respirator (i.e., self-contained breathing apparatus, supplied-air respirator, or air-purifying respirator) that should be used, the type of clothing that must be worn, and the equipment needed to protect the head, eyes, face, ears, hands, arms, and feet.

In addition, NRT-1 recommends that medical personnel be made aware of significant chemical hazards in the community to prepare for possible hazardous materials incidents. It also states that emergency medical teams and hospital personnel must be trained in the proper methods for decontaminating and treating individuals exposed to hazardous chemicals.

## Hazard Analysis

Hazard analysis is a necessary component of comprehensive emergency planning for a community. It is a three-step decisionmaking process comprised of hazard identification, vulnerability analysis, and risk analysis. This section focuses primarily on hazard identification. Hazard analysis is usually the task of an agency (e.g., the fire department), the Disaster Committee, or the LEPC. EMS personnel should consult with the LEPC or their agency head to review the hazard analysis information for their area.

The first task in conducting such an analysis is to complete an inventory of the hazardous materials present in the community and to determine the nature of the hazard. This is a key step because it permits planners to describe and evaluate risks, and to allocate resources accordingly. However, the task of analyzing all relevant hazards may not prove cost effective for many communities. The planning committee should, therefore, assign priorities to the hazards found in its community and establish affordable limits for analysis. It should be noted that several federal agencies (e.g., DOT, FEMA, EPA) report that frequently encountered substances often pose the most prevalent dangers. These materials include fuels and chemicals, such as chlorine, ammonia, and hydrochloric and sulfuric acids. Such materials should be given special attention (vulnerability analysis) by the LEPC in the planning process.

In this context, a hazard is any situation that is capable of causing injury or impairing an individual s health. During the process of identifying hazards, facilities or transportation routes will be pinpointed that contain materials that are potentially dangerous to humans. The identification of hazards also should provide information on: (1) the types, quantities, and location(s) of hazardous materials in the community, or transported through a community; and (2) the nature of the hazard that would accompany incidents, such as explosions, spills, fires, and venting to the atmosphere.

Hazards should be identified at as many facilities in the community as possible. These include the obvious ones such as chemical plants, refineries, petroleum plants, storage facilities, and warehouses. In requesting information directly from facilities, remember that the planning provisions under SARA Title III require certain facilities to provide the LEPC with any information on the facility that the committee needs to develop and implement its plan. The LEPCs may provide assistance here, particularly if the committee includes industry representatives. It is essential that these industries or businesses understand the role this information plays in ensuring a sound emergency response plan. As previously stated, placing airport, business, or industrial representatives on the community-wide planning committee, as required under SARA Title III, should facilitate their cooperation. The assistance and cooperation of a facility that regularly deals with hazardous materials also presents the local planning unit with a wide array of services. For example, such a facility can provide technical experts, Spill Prevention Control and Countermeasure (SPCC) plans, training and safe handling instructions, and cleanup capabilities.

In identifying hazards, hospitals and educational and governmental facilities should not be overlooked since they all contain a variety of chemicals. Major transportation routes and transfer points, such was airports, vessels in port, railroad yards, and trucking terminals, should also be included in the overall hazards identification plan. SARA Title III planning provisions address many of these potential transportation risk areas by requiring facility cooperation in plan preparation and by including specific risk areas as well as a wide range of chemical handlers, from manufacturers to service-related businesses.

Risk analysis includes the probable damage that may occur if a chemical incident occurs. Information that is necessary for risk analysis includes:

- The type of risk to humans, such as an acute, chronic, or delayed reaction.
- The groups that are most at risk.
- The type of risk to the environment, such as permanent damage or a recoverable condition.

Many documents can be of assistance in conducting a risk analysis. Risk analysis in transportation settings is outlined in the DOT s *Community Teamwork: Working Together To Promote Hazardous Materials Safety, A Guide for Local Officials.* In conjunction with FEMA and DOT, EPA published a supplement to NRT-1 in December 1987. This document, entitled *Technical Guidance for Hazardous Analysis* and often referred to as the Green Book, provides technical assistance to LEPCs in assessing the lethal hazards associated with potential airborne releases of extremely hazardous substances.

## Training

Each member of an EMS agency (career, volunteer, or combined service) is mandated to receive 8 hours of hazmat awareness training each year. This training provides an introduction to basic response principles: the importance of incident recognition, assessment, and taking defensive strategies until more qualified assistance arrives. The National Fire Protection Association (NFPA) has published several standards for fire departments regarding hazardous materials response. In 1997 it released *Standards for Professional Competence of EMS Responders to Hazardous Materials Incidents (NFPA 473),* which outlines desired levels of competence for EMS personnel responding to hazmat incidents. Level I EMS/HM-trained responders are prepared with the knowledge and skills to safely deliver emergency medical care in the Support (Cold) Zone, whereas Level II EMS/HM responders are prepared to provide care to individuals who still may pose a risk of secondary contamination (i.e., working in the Contamination Reduction (Warm) Zone). Personnel at this level are also able to coordinate EMS activities at a hazardous materials incident and provide medical
support for hazmat response personnel. All EMS agency administrators should familiarize themselves with this standard, as well as with NFPA 472, *Standards for Professional Competence of Responders to Hazardous Materials Incidents.* These two courses and other instructional programs, such as the Domestic Preparedness: Weapons of Mass Destruction Training program, are recommended for all EMS personnel who will be responding to hazardous materials calls.

A growing number of commercially available audiovisual and computer-based training programs are becoming available which provide accurate, timely, and cost-effective instruction. In addition, numerous sites on the Internet offer free access to educational materials pertaining to hazardous materials (e.g., www.NLM.NIH.gov/pubs/FactSheets/toxnctfs.html; www.ATSDR.cdc.gov/hazdat.html).

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## Section II. Emergency Medical Services Response to Hazardous Materials Incidents

### Hazard Recognition

When dispatched to the scene of an incident, emergency response personnel may not be aware that the situation involves hazardous materials. As a result, emergency medical services personnel should always be alert to the possibility that they may be dealing with a chemically contaminated individual, and should ask the dispatch personnel and victims about the nature of the event. An injury at a hazardous materials incident need not invariably involve chemical exposure: it could have resulted from a physical accident, such as slipping off a ladder. But as a routine precaution, the involvement of hazardous materials should be considered a possibility on every call. The manual *Recognizing and Identifying Hazardous Materials* (produced by the National Fire Academy and the National Emergency Training Center) states that there are six primary clues that may signify the presence of hazardous materials. These clues are included below to facilitate and expedite the prompt and correct identification of any hazardous materials at the scene of an incident. Dispatch protocols should seek to obtain information about these clues and relay the information to field personnel as soon as possible. Certain combinations of patient symptoms such as nausea, dizziness, burning eyes or skin, or cyanosis should also suggest to the dispatch staff the presence of hazardous materials.

The six principle clues to hazardous materials incidents are:

- **Occupancy and Location.** Community preplanning should identify the specific sites that contain hazardous materials. In addition, emergency personnel should be alert to the obvious locations in their communities that use and/or store hazardous materials (e.g., laboratories, factories, farm and paint supply outlets, construction sites). The Department of Labor s Material Safety Data Sheets (MSDSs) should also be available, especially for any particularly dangerous chemicals kept on site. It should be kept in mind, however, that these data sheets may have incomplete information and that the medical information provided is generally at a basic first aid level.

- **Container Shape.** Department of Transportation (DOT) regulations delineate container specifications for the transport of hazardous materials. There are three categories of packaging: stationary bulk storage containers at fixed facilities that come in a variety of sizes and shapes; bulk transport vehicles, such as rail and truck tank cars, that vary in shape depending upon the cargo; and labeled fiberboard boxes, drums, or cylinders for smaller quantities of hazardous materials. The shape and configuration of the container can often be a useful clue to the presence of hazardous materials.

- **Markings/Colors.** Certain transportation vehicles must use DOT markings, including identification (ID) numbers. Identification numbers, located on both ends and both sides, are required on all cargo tanks, portable tanks, rail tank cars, and other packages that carry hazardous materials. Railcars may have the names of certain substances stenciled on the side of the car. A marking scheme designed by the National Fire Protection Association (NFPA 704M System) identifies hazard characteristics of materials at terminals and industrial sites, but does not provide product-specific information. This system uses a diamond divided into four quadrants. Each quadrant represents a different characteristic: the left, blue section refers to health; the top, red quarter pertains to flammability; the right, yellow area is for reactivity; and the bottom, white quadrant highlights special information (e.g., ~~W~~ indicates dangerous when wet, Oxy stands for oxidizer).

A number from zero through four in each quadrant indicates the relative risk of the hazard, with zero representing the minimum risk. This system does not indicate what the product is, the quantity, or its exact location. In addition, it does not reveal the compound s reactivity with other chemicals. The military also uses distinctly shaped markings and signs to designate certain hazards. These markings may be found on vehicles, on the products themselves, or on shipping papers.

- **Placards/Labels.** These convey information through use of colors, symbols, Hazard Communication Standards, American National Standard Institute (ANSI) Standards for Precautionary Labeling of Hazardous Industrial Chemicals, United Nations Hazard Class Numbers, and either hazard class wording or four-digit identification numbers. Placards are used when hazardous materials are being stored in bulk (usually over 1,001 lb), such as in cargo tanks. Labels designate hazardous materials kept in smaller packages. Caution must be exercised, however, because the container or vehicle holding a hazardous material may be improperly labeled or recorded, or it may not have any exterior warning.

- **Shipping Papers.** Shipping papers can clarify what is labeled as dangerous on placards. They should provide the shipping name, hazard class, ID number, and quantity, and may indicate whether the material is waste or poison. Shipping papers, which must accompany all hazardous material shipments, are now required to list a 24-hour emergency information telephone number. The location where the shipping papers are stored can be problematical; often they are found in close proximity to the hazardous material(s) or in other locations not easily accessible during an emergency. Shipping papers should remain at the incident scene for use by all response personnel.

- **Senses.** Odor, vapor clouds, dead animals or fish, fire, and skin or eye irritation can signal the presence of hazardous materials. Generally, if one detects an odor of hazardous materials, it should be assumed that exposure has occurred and the individual is still in the danger area, although some chemicals have a detectable odor at levels below their toxic concentrations. Some chemicals, however, can impair an individual s sense of smell (e.g., hydrogen sulfide), and others have no odor, color, or taste at all (e.g., carbon monoxide). Binoculars are helpful to ascertain visible information from a safe distance.

Appendix A provides greater detail on NFPA s 704M system; the DOT s hazardous materials marking, labeling, and placarding guide; and the Department of Labor s MSDS. It is important that any and all available clues are used in substance identification, especially obvious sources such as the information provided on a label or in shipping papers.

The aim of emergency personnel should be to make a chemical-specific identification while exercising caution to prevent exposure to any chemicals. Identifying the hazardous material and obtaining information on its physical characteristics and toxicity are vital steps to the responder s safety and effective management of the hazardous materials incident. Since each compound has its own unique set of physical and toxicological properties, early and accurate identification of the hazardous material(s) involved allows emergency personnel to initiate appropriate management steps at the scene.

Many resources are available to provide information concerning response to and planning for hazardous materials incidents. A selected bibliography of written material is included at the end of each section of this guidebook; it is not, however, a complete list of the materials available. Printed reference materials provide several advantages: they are readily available, they can be kept in the response vehicle, they are not dependent on a power source or subject to malfunction, and they are relatively inexpensive. Disadvantages include the difficulty of determining the correct identity for an unknown chemical through descriptive text, the logistics of keeping the materials current, the increased risk of the documents being lost or damaged because of their small size and soft cover bindings, and the problem that no single volume is capable of providing all the information that may be needed. EMS personnel should have immediate access to and be proficient at using the DOT s *North American Emergency Response Guidebook* and other medically-oriented response documentation.

There is also a vast array of telephone and computer-based information sources concerning hazardous materials. They can help by describing the toxic effects of a chemical, its relative potency, and the potential for secondary contamination. They may also recommend decontamination procedures, clinical management strategies, and advice on the adequacy of specific types of protective gear. Exhibit II-lA is a partial listing of the many information resources available by telephone. Exhibit II-1B is a list of suggested telephone numbers that should be filled in for your community. The regional Poison Control Center, the Soldier and Biological Chemical Command (SBCCOM), and the Centers for Disease Control (CDC) can be contacted 24 hours a day to provide vital information on the medical management of hazardous materials exposure. Exhibit II-2 provides a partial listing of the available computerized and online information sources. Note, however, that not all online databases are peer reviewed; some medical management information may be based only on DOT or MSDS data. Care should be exercised when selecting information sources. Planning is an essential part of every response, and many of these resources can provide guidance in the formation of an effective response plan.

## Exhibit II-1A
## Telephone Information and Technical Support References

| Resource | Contact | Services Provided |
|---|---|---|
| Chemical Transportation Emergency Center (CHEMTREC) | 1-800-424-9300 | 24-hour emergency number connecting with manufacturers and/or shippers. Advice provided on handling, rescue gear, decontamination considerations, etc. Also provides access to the Chlorine Emergency Response Plan (CHLOREP). |
| Agency for Toxic Substances and Disease Registry (ATSDR) | 1-404-639-6360 | 24-hour emergency number for health-related support in hazardous materials emergencies, including onsite assistance. |
| Bureau of Explosives | 1-719-585-1881 | Contact number for technical questions about railway transport of hazardous materials. For emergencies, call CHEMTREC (1-800-424-9300). |
| Emergency Planning and Community Right-to-Know Act (EPCRA) and Resource Conservation and Recovery Act (RCRA) Information Hotline | 1-800-424-9346 | Available 9:00 a.m. to 6:00 p.m. (EST). Provides information on SARA Title III, list of extremely hazardous substances, and planning guidelines. |
| Environmental Protection Agency (EPA) Regional Offices | website: www.epa.gov/regional | Environmental response teams available for technical assistance. |
| Region I (CT, ME, MA, NH, RI, VT) | 1-617-918-1111 | |
| Region II (NJ, NY, PR, VI) | 1-212-637-3000 | |
| Region III (DE, DC, MD, PA, VA, WV) | 1-215-814-2900; intra-regional only: 1-800-438-2474 | |
| Region IV (AL, FL, GA, KY, MS, NC, SC, TN) | 1-404-562-9900; Emergency Response & Removal Branch: 1-800-564-7577 | |
| Region V (IL, IN, MI, MN, OH, WI) | 1-312-353-2000 | |
| Region VI (AR, LA, NM, OK, TX) | 1-214-665-2200 | |
| Region VII (IA, KS, MO, NE) | 1-913-551-7003 | |
| Region VIII (CO, MT, ND, SD, UT, WY) | 1-303-312-6312 | |
| Region IX (AZ, CA, HI, NV; Pacific Islands AS, FM, GU, MH, MP, PW) | 1-415-744-1500; emergencies: 1-415-744-2000 | |
| Region X (AK, ID, OR, WA) | 1-206-553-1200 | |

## Exhibit II-1A (continued)

| Resource | Contact | Services Provided |
|---|---|---|
| National Animal Poison Control Center | 1-800-548-2423<br>1-888-426-4435 | 24-hour consultation services concerning animal poisonings or chemical contamination. Provides an emergency response team to investigate incidents and to perform laboratory analysis. |
| National Pesticides Information Retrieval System (NPIRS) | 1-765-494-6616<br>website:<br>ceris.purdue.edu/npirs | Contact information for help in searching NPIRS database to get fact sheets on pesticides, insecticides, fungicides, and state and federally registered chemicals. |
| National Pesticide Telecommunications Network (NPTN) (Oregon State University) | 1-800-858-7378<br>website:<br>ace.orst.edu/info/nptn | Provides information about pesticide-related topics, including pesticide products, recognition and management of pesticide poisoning, toxicology, environmental chemistry, referrals for laboratory analyses, investigation of pesticide incidents, emergency treatment, safety, health and environmental effects, cleanup, and disposal procedures. |
| National Response Center | 1-800-424-8802 | A federal hotline for reporting oil and chemical spills where hazardous materials are responsible for death, serious injury, property damage in excess of $50,000, or continuing danger to life and property. |
| U.S. Army Soldier and Biological Chemical Command (SBCCOM) | 1-800-368-6498 | 24-hour consultation service for threats and releases pertaining to chemical and biological agents. |

## Exhibit II-1B
## Local Telephone Information and Technical Support Resource Worksheet

| Resource | Contact (fill in for future reference) | Services Provided (fill in for future reference) |
|---|---|---|
| EPA Regional or State Office | | |
| Regional Poison Control Center | | |
| State Emergency Response Commission | | |
| State Health Department | | |
| State Emergency Management Office | | |
| Local Fire Department | | |
| Local Hazardous Materials | | |
| Response Team | | |
| Community Police Department | | |
| Local Emergency Planning Committee | | |
| Local Health Department | | |
| State Department of Natural Resources | | |
| FEMA Regional Office | | |
| State Agriculture Office | | |
| State Lab Office | | |
| State EMS Office | | |
| Hyperbaric Medicine Chamber | | |
| Burn Center | | |
| CDC | | |
| U.S. Army Soldier and Biological Chemical Command | | |

## Exhibit II-2
## Computerized Data Sources for Information and Technical Support

| Data System | Contact | Description |
|---|---|---|
| CAMEO | CAMEO Database Manager<br>National Oceanic and Atmospheric Administration (NOAA)<br>Hazardous Materials Response Division<br>7600 Sand Point Way, N.E.<br>Seattle, Washington 98115<br>(206) 526-6317<br>website: www.epa.gov/ceppo/cameo | Computer-aided management of emergency operations available to on-scene responder(s). Chemical identification database assists in determining substance(s) involved, predicting downwind concentrations, providing response recommendations, and identifying potential hazards. |
| CHRIS | CIS, Inc.<br>c/o Oxford Molecular Group<br>11350 McCormick Road<br>Executive Plaza, Suite 1100<br>Hunt Valley, Maryland 21031<br>(800) 247-8737<br>website: www.oxmol.com/software/cis/details/CHRIS.shtml | Chemical Hazard Response Information System, developed by the Coast Guard and comprised of reviews on fire hazards, fire-fighting recommendations, reactivities, physicochemical properties, health hazards, use of protective clothing, and shipping information for over 1,000 chemicals. |
| HAZARDTEXT | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111-4740<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | Assists responders dealing with incidents involving hazardous materials, such as spills, leaks, and fires. Provides information on emergency medical treatment and recommendations for initial hazardous response. |
| HMIS | Kevin Coburn<br>Information Systems Manager<br>U.S. Department of Transportation<br>D.H.M. 63 - Room 8104<br>400 7th Street SW<br>Washington, D.C. 20590-0001<br>website: www.dlis.dla.mil/hmis.htm | Hazardous Material Information Systems contains information on hazardous materials. Transportation-related incidents may be reported on DOT form 5800.1 (Hazardous Materials Incident Report Form). |
| HSDB | HSDB Representative<br>National Library of Medicine<br>Specialized Information Systems<br>8600 Rockville Pike<br>Bethesda, Maryland 20894<br>(301) 496-6531<br>website: sis.nlm.nih.gov/sis1 | Hazardous Substances Data Bank, compiled by the National Library of Medicine, provides reviews on the toxicity, hazards, and regulatory status of over 4,000 frequently used chemicals. |

## Exhibit II-2 (continued)

| Data System | Contact | Description |
|---|---|---|
| 1st MEDICAL RESPONSE PROTOCOLS | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | Helps develop training programs and establish protocols for first aid or initial workplace response to a medical emergency. |
| MEDITEXT | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | Provides recommendations regarding the evaluation and treatment of exposure to industrial chemicals. |
| OHMTADS | Oxford Molecular Group, Inc.<br>11350 McCormick Rd.<br>Executive Plaza 3, Suite 1100<br>Hunt Valley, Maryland 21031<br>(800) 247-8737<br>website: www.oxmol.com/software/cis/details/OHMTADS.shtml | Oil and Hazardous Materials/Technical Assistance Data Systems provides information on the effects of spilled chemical compounds and their hazardous characteristics and properties, assists in identifying unknown substances, and recommends procedures for handling cleanups. |
| TOMES | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | The Tomes Plus Information Systems is a series of comprehensive databases on a single CD-ROM disc. It provides information regarding hazardous properties of chemicals and medical effects from exposure. The Tomes Plus database contains Meditext, Hazardtext, HSBD, CHRIS, OHMTADS, and 1st Medical Response Protocols. |
| TOXNET | Toxicology Data Network (TOXNET)<br>National Library of Medicine<br>Specialized Information Services<br>8600 Rockville Pike<br>Bethesda, Maryland 20894<br>(301) 496-6531<br>website: sis.nlm.nih.gov/sis1 | A computerized system of three toxicologically oriented data banks operated by the National Library of Medicine the Hazardous Substances Data Bank, the Registry of Toxic Effects of Chemical Substances, and the Chemical Carcinogenesis Research Information System. TOXNET provides information on the health effects of exposure to industrial and environmental substances. |

## Principles of Toxicology for Emergency Medical Service Personnel

Exposure to hazardous chemicals may produce a wide range of adverse health effects. The likelihood of an adverse health effect occurring, and the severity of the effect, are dependent on: (1) the toxicity of the chemical; (2) the route of exposure; (3) the nature and extent of exposure; and (4) factors that affect the susceptibility of the exposed person, such as age and the presence of chronic disease. To better understand potential health effects, emergency medical personnel should understand the basic principles and terminology of toxicology.

Toxicology is the science that deals with poisons and their effect on living organisms. Examples of these adverse effects, sometimes called toxic end points, include carcinogenicity (development of cancer), hepatotoxicity (liver damage), neurotoxicity (nervous system damage), and nephrotoxicity (kidney damage). This is merely a sample list of toxic end points that might be encountered (Exhibit II-3).

Toxic chemicals often produce injuries at the site which they come into contact with the body. A chemical injury at the site of contact, typically the skin and the mucous membranes of the eyes, nose, mouth, or respiratory tract, is termed a *local toxic effect.* Irritant gases such as chlorine and ammonia can, for example, produce a localized toxic effect in the respiratory tract, while corrosive acids and bases can result in local damage to the skin. In addition, a toxic chemical may be absorbed into the bloodstream and distributed to other parts of the body, producing *systemic effects*. Many pesticides, for example, are absorbed through the skin, distributed to other parts of the body, and produce adverse effects such as neurological, cardiac, respiratory, or other problems. It is important for medical providers to recognize that exposure to chemical compounds can result not only in the development of a single systemic effect but also in the development of multiple systemic effects or a combination of systemic and local effects. Some of these effects may be delayed, sometimes for as long as 48 hours or more. Health effects can also be acute or chronic. Acute health effects are short-term effects that manifest within hours or days, such as vomiting or diarrhea. Chronic health effects are long-term effects that may take years to manifest, such as cancer.

### Routes and Extent of Exposure

There are three main routes of chemical exposure: inhalation, dermal contact (with skin or mucous membranes), and ingestion. *Inhalation* results in the rapid introduction of toxic compounds into the respiratory system. Most of the compounds that are commonly inhaled are gases or vapors of volatile liquids. However, solids and liquids can be inhaled as dusts or aerosols. Inhalation of toxic agents generally results in a rapid and effective absorption of the compound into the bloodstream because of the large surface area of the lung tissue and number of blood vessels in the lungs. Knowing a chemical s vapor pressure (VP) can be useful in determining the inhalation risk for a particular exposure. The lower the VP, the less likely the chemical will produce an inhalable gas and vice versa. Water solubility is also an important contributor for symptom development. Irritant agents that are water soluble usually cause early upper respiratory tract irritation, resulting in coughing and throat irritation. Partially water-soluble chemicals penetrate into the lower respiratory system, causing delayed symptoms (12 to 24 hours) which include trouble breathing, pulmonary edema, and coughing up blood. Asphyxiants are chemicals that impede the body s ability to obtain or utilize oxygen. Simple asphyxiants are inert gases (e.g., argon, propane, nitrogen) that displace oxygen in inspired air. Chemical asphyxiants produce harm by preventing oxygen delivery or utilization for energy production by the body s cells. Carbon monoxide and cyanide are examples of asphyxiants.

**Exhibit II-3**
**Examples of Adverse Health Effects from Exposure to Toxic Chemicals**

| Toxic End Point | Target Organ Systems | Example of Causative Agent | Health Effect Acute | Health Effect Chronic |
|---|---|---|---|---|
| Carcinogenicity | All | Benzene | Dermatitis<br>Headache<br>Dizziness<br>Sleepiness | Acute myelogenous leukemia |
| Hepatotoxicity | Liver | 1, 1, 1-1 trichloroethane | Vomiting<br>Abdominal pain<br>Dizziness | Liver necrosis<br>Fatty liver |
| Neurotoxicity | Nervous system | Lead | Nausea<br>Vomiting<br>Abdominal pain | Wrist drop<br>IQ deficits<br>Encephalopathy |
| Nephrotoxicity | Kidney | Cadmium | Vomiting<br>Diarrhea<br>Chest pain | Kidney damage<br>Anemia |

*Dermal contact* does not typically result in as rapid absorption as inhalation, although some chemicals are readily taken in through the skin. Many organic compounds are lipid (fat) soluble and can therefore be rapidly absorbed through the skin and mucus membranes. Absorption is increased by damage to the skin and by warm weather, and some areas of the body (e.g., the groin) absorb chemicals faster than others (e.g., the hands).

*Ingestion* is a less common route of exposure for emergency response personnel at hazardous materials incidents. However, incidental hand-to-mouth contact, smoking, and swallowing of saliva and mucus that contains contaminants may also result in exposure by this route. In addition, emergency medical personnel in both hospital and prehospital settings treat chemical exposures in patients who have ingested toxic substances as a result of accidental poisonings or suicide attempts.

Compounds may also be introduced into the body through *injection*, although this is a relatively uncommon scenario in spills or discharges of hazardous materials. Explosions may result in injection injuries and lead to imbedded foreign bodies, which may themselves be chemically contaminated.

The route by which personnel are exposed to a compound plays a role in determining the total amount of the compound taken up by the body because a compound may be absorbed by one route more readily than by another. In addition, the route of exposure may affect the nature of the symptoms that develop. The amount of the compound absorbed by the body also depends on the duration of exposure and the concentration of the compound to which one is exposed.

It is important to recognize that children may be more susceptible to many toxic exposures. A child s immature central nervous system, liver, and renal system increases his or her susceptibility to injury as a result of exposure to chemicals. Children are also likely to receive a higher dose relative to body weight than an adult. This occurs for a number of reasons. First, children are shorter than adults and since most toxic gases are heavier than air, the concentrations increase as you get closer to the ground. Second, children have a larger lung surface area relative to their weight than adults, as well as a greater respiratory volume (liters/min/kg of body weight). It is also probable that the child s lung is a more effective absorbent surface than that of the adult. Third, children have a larger skin area relative to their weight than do adults, allowing more effective surface area for absorption in dermal exposures. A child s skin is more easily penetrated by chemicals, allowing for a more rapid and effective dermal absorption. Finally, children are more likely to ingest toxic chemicals because of increased hand-to-mouth behavior, including pica. All of these factors may lead to an increased dose relative to size in children as compared to adults, even when they all are exposed to the same scenario.

A complex relationship exists between the total amount of the compound absorbed by the body (dose) and the concentration of that compound in the environment. This relationship is important for emergency response personnel to understand because the adverse effects produced by a toxic compound are often related to the dose of that compound received by a patient. However, because we usually only monitor the concentration of the toxic substance in the environment (e.g., parts per million (ppm) of a compound in air), the actual dose of the compound received by the patient is seldom known. Factors specific to the exposed individual, such as area of skin surface exposed, presence of open wounds or breaks in the skin, and the rate and depth of respirations, are important in estimating the dose of the compound received by the patient. Injuries that disrupt the skin may lead to absorption of chemicals that would not normally penetrate the skin.

## Dose-Response Relationship

The effect produced by a toxic compound is primarily a function of the dose. This principle, termed the dose-response relationship, is a key concept in toxicology. Many factors affect the normal dose-response relationship and they should be considered when attempting to extrapolate toxicity data to a specific situation (Exhibit II-4).

**Exhibit II-4**
**Classification of Factors Influencing Toxicity**

| Type | Examples |
|---|---|
| Factors related to the chemical | Composition (salt, freebase, etc.); physical characteristics (size, liquid, solid, etc.); physical properties (volatility, solubility, etc.); presence of impurities; breakdown products; carriers |
| Factors related to exposure | Dose; concentration; route of exposure (inhalation, ingestion, dermal); duration |
| Factors related to the exposed person | Heredity; immunology; nutrition; hormones; age; sex; health status; preexisting diseases; pregnancy |
| Factors related to environment | Media (air, water, soil, etc.); additional chemicals present; temperature; humidity; air pressure; and fire |

Typically, as the dose increases, the severity of the toxic response increases. Humans exposed to 100 ppm of tetrachloroethylene, a solvent that is commonly used for dry-cleaning fabrics, may experience relatively mild symptoms, such as headache and drowsiness. However, exposure to 200 ppm tetrachloroethylene can result in a loss of motor coordination in some individuals, and exposure to 1,500 ppm tetrachloroethylene for 30 minutes may result in loss of consciousness (Exhibit II-5). As shown in Exhibit II-5, the severity of the toxic effect also depends on the duration of exposure, a factor that influences the dose of the compound in the body.

Toxicity information is often expressed as the dose of a compound that causes an effect in a percentage of the exposed subjects, which are usually experimental animals. These dose-response terms are often found in the Material Safety Data Sheets (MSDSs) and other sources of health information. One dose-response term that is commonly used is the lethal dose 50 ($LD_{50}$). This is the dose that is lethal to 50 percent of an animal population from exposure by a specific route (except inhalation) when given all in one dose. A similar term is the lethal concentration 50 ($LC_{50}$), which is the concentration of a material in air that on the basis of respiratory exposure in laboratory tests is expected to kill 50 percent of a group of test animals when administered as a single exposure (usually 1 hour). Exhibit II-6 lists a number of chemicals that may be encountered in dealing with hazardous materials incidents, and the reported acute $LD_{50}$ values of these compounds when they are administered by ingestion to rats.

**Exhibit II-5**
**Dose-Response Relationship for Humans Inhaling Tetrachloroethylene Vapors**

| Levels in Air | Duration of Exposure | Effects on Nervous System |
|---|---|---|
| 50 ppm | | Odor threshold |
| 100 ppm | 7 hours | Headache, drowsiness |
| 200 ppm | 2 hours | Dizziness, uncoordination |
| 600 ppm | 10 minutes | Dizziness, loss of inhibitions |
| 1,000 ppm | 1-2 minutes | Marked dizziness, intolerable eye and respiratory tract irritation |
| 1,500 ppm | 30 minutes | Coma |

From Exhibit II-6 it can be seen that a dose of 3,000 to 3,800 mg/kg tetrachloroethylene is lethal to 50 percent of rats that received the compound orally; however, only 6.4 to 10 mg/kg of sodium cyanide is required to produce the same effect. Therefore, compounds with low $LD_{50}$ values are more acutely toxic than substances with higher $LD_{50}$ values.

The $LD_{50}$ values that appear on an MSDS or in the literature must be used with caution by emergency medical personnel. These values are an index of only one type of response and give no indication of the ability of the compound to cause nonlethal, adverse or chronic effects. They also do not reflect possible additive effects from the mixture of chemicals sometimes found with exposure to hazardous materials. Furthermore, $LD_{50}$ values typically come from experimental animal studies. Because of the anatomical and physiological differences between animals and humans, it is difficult to compare the effects seen in experimental animal studies to the effects expected in humans exposed to hazardous materials in the field. $LC_{50}$ and $LD_{50}$ values are also usually determined in healthy adult animals. Values determined in young animals may be quite different, as may values determined in animals with an underlying disease. It is known that many chemicals are more toxic (lower $LD_{50}$ or $LC_{50}$ values) in young or newborn animals than in adults. This same age dependence may exist in humans. Because several organs, particularly the brain, are still developing in young children, damage to these organs may be more extensive and can be permanent. Also, infants may not be able to excrete chemicals from the body as efficiently as adults because their kidneys and liver are not fully developed. This may lead to longer and greater exposure to the chemical than would occur in an adult with the same relative exposure. The immaturity of metabolizing enzymes in the liver may lead to either increased or decreased toxicity in infants relative to adults. Which may occur is difficult to predict for many chemicals. Therefore, emergency medical personnel should remember that the $LD_{50}$ and $LC_{50}$ values are only useful for comparing the relative toxicity of compounds.

**Exhibit II-6**
**Acute $LD_{50}$ Values for Representative Chemicals When Administered Orally to Rats**

| Chemical | Acute Oral $LD_{50}$ (mg/kg)[1] |
|---|---|
| Sodium cyanide | 6.4-10 |
| Pentachlorophenol | 50-230 |
| Chlordane | 83-560 |
| Lindane | 88-91 |
| Toluene | 2,600-7,000 |
| Tetrachloroethylene | 3,000-3,800 |

[1] Milligrams of the compound administered per kilogram body weight of the experimental animal.

Responses to toxic chemicals may differ among individuals because of the physiological variability that is present in the human population. Some individuals, for example, are more likely to experience adverse health effects after exposure to a toxic chemical because of a reduced ability to metabolize that compound. The presence of preexisting medical conditions (e.g., chronic obstructive pulmonary disease (COPD), diabetes, renal disease) can also increase one s susceptibility to toxic chemicals. Respiratory distress in patients or workers with asthma may be triggered by exposure to toxic chemicals at lower levels than might be expected to produce the same effect in individuals without respiratory disease. Factors such as age, personal habits (e.g., smoking, diet), previous exposure to toxic chemicals, and medications may also increase an individual s sensitivity to toxic chemicals. Therefore, exposure to concentrations of toxic compounds that would not be expected to result in the development of a toxic response in most individuals may cause an effect in susceptible individuals. Not all chemicals, however, have a threshold level. Some carcinogens (cancer-causing chemicals) may produce a response (tumors) at any dose level, and any exposure to these compounds may be associated with some risk of developing cancer. Thus, literature values for levels which are not likely to produce an effect do not guarantee that an effect will not occur.

EMS personnel need a strong knowledge of toxicology principles to assess the degree of hazard in a hazmat incident. Among the key questions to consider are:

- What is the route of exposure and how can further exposure be minimized?
- Do the acute symptoms give clues as to the potential exposure and chronic health effects?

- Is this individual at increased risk because of greater susceptibility: for example, a child or an adult with preexisting health problems?
- Can an exposure dose be estimated and will this help to estimate short- and long-term health effects?

## Exposure Limits

The various occupational exposure limits found in the literature or in an MSDS are based primarily on time-weighted average limits, ceiling values, or ceiling concentration limits to which the worker can be exposed without adverse effects. Examples of these are listed in Exhibit II-7A.

The values listed in Exhibit II-7A were established to provide worker protection in occupational settings. Because the settings in which these values are appropriate are quite different than an uncontrolled spill site, it is difficult to interpret how these values should be used by emergency medical personnel dealing with a hazardous materials incident. These values are designed for a healthy adult working population and have limited utility when applied to some of the at risk groups previously mentioned. At best, TLV, PEL, IDLH, and REL values can be used as benchmarks for determining relative toxicity, and perhaps to assist in selecting appropriate levels of personal protective equipment (PPE). Furthermore, these occupational exposure limits are only useful if trained personnel with special detection equipment are available for measuring the levels of toxic chemicals at the spill site. Of the occupational exposure limit values shown in Exhibit II-7A, only the OSHA values are regulatory limits. The ACGIH values are for guidance only and have certain caveats that may or may not affect the usefulness of the values. Some of these conditions are individual susceptibility or aggravation of a preexisting condition. Because of the limitations of PELs and TLVs, special exposure limits have been established. Emergency Response Planning Guidelines (ERPGs), Short-term Public Emergency Guidance Levels (SPEGLs), and Acute Exposure Guidelines (AEGLs, under development by the EPA), have been designed to assist emergency response personnel in making decisions regarding nonworkplace exposure (Exhibit II-7B). Emergency medical personnel responsible for the management of chemically contaminated patients should be familiar with all of these exposure limits because they will be encountered in various documents dealing with patient care or the selection of PPE. Additional expertise can be obtained by taking classes offered by the ACGIH or at many colleges and universities.

This brief discussion highlights some fundamental concepts of toxicology. Emergency medical personnel responsible for managing chemically contaminated patients are encouraged to obtain further training in their recognition and treatment. A list of general toxicology references is provided at the end of this section that will allow emergency medical personnel to undertake a more in-depth examination of the principles of toxicology.

## Exhibit II-7A
## Occupational Exposure Limits

| Value | Abbreviation | Definition |
|---|---|---|
| Threshold Limit Value (ACGIH)[1] | TLV | Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. |
| Threshold Limit Value: Time-Weighted Average (ACGIH)[1] | TLV-TWA | The time-weighted average concentration for a normal 8-hour work day and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. |
| Threshold Limit Value: Short-Term Exposure Limit (ACGIH)[1] | TLV-STEL | The concentration to which workers can be exposed continuously for a short period of time without suffering from (1) irritation, (2) chronic or irreversible tissue damage, or (3) narcosis of a sufficient degree to increase the likelihood of accidental injury, to impair self-rescue, or to materially reduce work efficiency; and provided that the daily TLV-TWA is not exceeded. |
| Threshold Limit Value: Ceiling (ACGIH)[1] | TLV-C | The concentration that should not be exceeded during any part of the working exposure. |
| Permissible Exposure Limit (OSHA)[2] | PEL | Same as TLV-TWA. |
| Immediately Dangerous to Life and Health (OSHA)[2] | IDLH | A maximum airborne concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects. |
| Recommended Exposure Limit (NIOSH)[3] | REL | Highest allowable airborne concentration that is not expected to injure a worker; expressed as a ceiling limit or time-weighted average for an 8- or 10-hour work day. |

[1] American Conference of Governmental Industrial Hygienists

[2] Occupational Safety and Health Administration

[3] National Institute for Occupational Safety and Health

## Exhibit II-7B
## General Population Exposure Limits

| Value | Abbreviation | Definition |
|---|---|---|
| Emergency Response Planning Guidelines (AIHA)[1] | ERPG | Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without (1) experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor (ERPG-1), (2) experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual s ability to take protective action (ERPG-2), or (3) experiencing or developing life-threatening health effects (ERPG-3). |
| Short-term Public Emergency Guidance Level (NRC)[2] | SPEGL | An acceptable concentration for unpredicted, single, short-term exposure of the general public in emergency situations. May be developed for different exposure periods (e.g., 1, 2, 4, 8, 16, 24 hours). |
| Acute Exposure Guidelines (EPA NAC/AEGL)[3] | AEGL | Proposed short-term threshold or ceiling exposure value intended for the protection of the general public, including susceptible or sensitive individuals but not those who are hypersusceptible or hypersensitive. Represents the airborne concentration of a substance at or above which it is predicted that the general population (as defined above) could experience (1) notable discomfort (AEGL-1), (2) irreversible or other serious, long-lasting effects or impaired ability to escape (AEGL-2), or (3) life-threatening effects or death (AEGL-3). Developed for four exposure periods: 30 minutes, and 1, 4 , and 8 hours. Synonymous with the NAS[4] term, Community Emergency Exposure Levels (CEELs). |

[1] American Industrial Hygiene Association

[2] National Research Council

[3] EPA National Advisory Committee/AEGL Committee

[4] National Academy of Sciences

## Personnel Protection and Safety Principles

This section provides emergency medical services personnel with information on protective equipment and safety principles. In the majority of cases, however, EMS staff will not experience incidents involving chemically contaminated patients frequently enough to keep them optimally trained or their equipment properly maintained. Staff must be trained initially in the proficient use of personal protective equipment (PPE), specifically respiratory equipment, and must maintain that proficiency. According to state and federal regulations, equipment must be maintained according to OSHA specifications; for example, respirators and their cartridges have to be properly fitted, tested, and stored. Many EMS agencies, given their workload and fiscal constraints, may not be able to expend the funds and time necessary to provide the highest level of PPE protection for their employees. EMS personnel should, at a minimum, be prepared to work in Level C attire (see below, *Levels of Protection*). In cases where EMS personnel have no PPE, they should make arrangements with the local fire department or hazmat team to be ready, if the situation warrants, to completely decontaminate patients, especially those who are to be transported to a hospital. Considerations in determining what an EMS s capabilities should be include the number of incidents occurring locally (several per week versus only a few per year), proximity to industries or transportation routes that have the potential for a hazardous materials incident (see Section I SARA Title III), and risks posed from terrorism.

## Federal Regulations Pertaining to Use of Personal Protective Equipment (PPE)

The term personal protective equipment (PPE) is used in this document to refer to both clothing and equipment. The purpose of PPE is to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered at a hazardous materials incident.

**Training is essential before any individual attempts to use PPE.** OSHA standards mandate specific training requirements (8 hours of initial training or sufficient experience to demonstrate competency) for personnel engaged in emergency response to hazardous substances incidents at the First Responder Operations Level. In addition, each agency must develop a health and safety program and provide for emergency response. These standards also are intended to provide particular protection for those who respond to hazardous materials incidents, such as firefighters, police officers, and EMS personnel. OSHA s final rule (March 6, 1989, 29 CFR (1910.120)) as it applies to emergency medical personnel states:  Training shall be based on the duties and functions to be performed by each responder of an emergency response organization.

No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus, PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. In general, the greater the level of PPE protection, the greater are the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Excessive protection can be as hazardous as underprotection, and should be avoided. In addition, personnel should not be expected to use PPE without adequate training.

The two basic objectives of any PPE program are to protect the wearer from safety and health hazards and to prevent injury to the wearer from incorrect use and/or malfunction of the PPE. To

accomplish these goals, a comprehensive PPE program should include: (1) hazard identification; (2) medical monitoring; (3) environmental surveillance; (4) selection, use, maintenance, and decontamination of PPE; and (5) training.

## PPE Complications

Personnel wearing PPE are likely to encounter a number of potential problems, including limited visibility, reduced dexterity, claustrophobia, restricted movement, suit breach, insufficient air supply, dehydration, and the effects of heat and cold. Only individuals who are physically fit and have met the OSHA/NIOSH/NFPA training requirements should be wearing PPE during an incident. Proper donning and doffing procedures must be followed, with assistance from other onsite personnel. Medical surveillance evaluations should be conducted on all personnel both before and immediately after their use of PPE. Personnel not meeting prescribed inclusion criteria set by the hazmat team or by the EMS Medical Director should be reassigned to an area not requiring the use of PPE. The actions of all personnel wearing PPE should be closely observed by the Safety Officer and others during each work period. In addition, an emergency distress signal should be identified in the briefing before individuals enter the work area. Following the completion of technical decontamination, all personnel should be examined to ascertain marked changes in health. Appropriate medical care should be initiated when illness or injury is discovered.

## Levels of Protection

EPA has designated four levels of protection to assist in determining which combinations of respiratory protection and protective clothing should be employed:

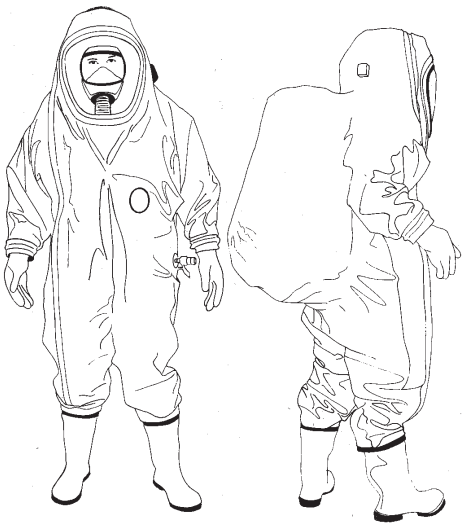
**Level A** protection should be worn when the highest level of respiratory, skin, eye, and mucous membrane protection is needed. It consists of a fully-encapsulated, vapor-tight, chemical-resistant suit, chemical-resistant boots with steel toe and shank, chemical-resistant inner/outer gloves, coveralls, hard hat, and self-contained breathing apparatus (SCBA).

**Level B** protection should be selected when the highest level of respiratory protection is needed, but a lesser degree of skin and eye protection is required. It differs from Level A only in that it provides splash protection through use of chemical-resistant clothing (overalls and long-sleeved jacket, two-piece chemical splash suit, disposable chemical-resistant coveralls, or fully- encapsulated, non-vapor-tight suit and SCBA).

**Level C** protection should be selected when the type of airborne substance(s) is known, concentration is measured, criteria for using air-purifying respirators are met, and skin and eye exposures are unlikely. This involves a full facepiece, air-purifying, canister-equipped respirator and chemical-resistant clothing. It provides the same degree of skin protection as Level B, but a lower level of respiratory protection.

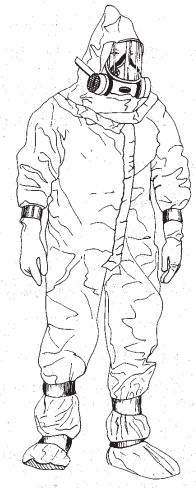
**Level D** is primarily a work uniform. It provides no respiratory protection and minimal skin protection, and it should not be worn on any site where respiratory or skin hazards exist.

Exhibit II-8 illustrates these four levels of protection. For more information on this subject, Appendix C outlines the protective equipment recommended for each level of protection.

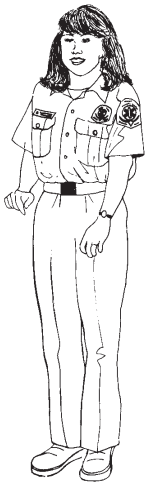


**Level A**

**Level B**



**Level C**



**Level D**

**Exhibit II-8**
**Levels of Protection**

Factors to be considered in selecting the proper level of protection include the potential routes of entry for the chemical(s), the degree of contact, and the specific task assigned to the user. Activities can also be undertaken to determine which level of protection should be chosen. The EPA and NIOSH recommend that initial entry into unknown environments or into a confined space that has not been chemically characterized be conducted wearing at least Level B, if not Level A**,** protection.

## Routes of Entry

PPE is designed to provide emergency medical personnel with protection from hazardous materials that can affect the body by one of three primary routes of entry: inhalation, ingestion, and direct contact. *Inhalation* occurs when emergency personnel breathe in chemical fumes or vapors. Respirators are designed to protect the wearer from contamination by inhalation but they must be worn properly and fit-tested frequently to ensure continued protection. *Ingestion* usually is the result of a health care provider transferring hazardous materials from his hand or clothing to his mouth. This can occur unwittingly when an individual wipes his mouth with his hand or sleeve, eats, drinks, or smokes tobacco. *Direct contact* refers to chemical contact with the skin or eye. Skin is protected by garments, and full-face respirators protect against ingestion and direct eye contact. Mucous membranes in the mouth, nose, throat, inner ear, and respiratory system may be affected by more than one of these routes of entry. Many hazardous materials adhere to and assimilate with the moist environment provided by these membranes, become trapped or lodged in the mucus, and are subsequently absorbed or ingested.

## Chemical Protective Clothing (CPC)

Protective clothing is designed to prevent direct contact of a chemical contaminant with the skin or body of the user. There is, however, no one single material that will afford protection against all substances. As a result, multilayered garments may be employed in specific situations despite their negative impact on dexterity and agility. CPC is designed to afford the wearer a known degree of protection from a known type, a known concentration, and a known length of exposure to a hazardous material, but only if it is properly fitted and worn correctly. Improperly used equipment can expose the wearer to danger. Another factor to keep in mind when selecting CPC is that most protective clothing is designed to be impermeable to moisture, thus limiting the transfer of heat from the body through natural evaporation. This is a particularly important factor in hot environments or for strenuous tasks since such garments can increase the likelihood of heat-related injuries. Research is now underway to develop lightweight suits that are breathable but still protective against a wide range of chemicals. Cooling vests are sometimes used in warm weather situations to keep the body temperature normal, but with mixed results.

Essential to any protective ensemble are chemical resistant boots with steel toe and shank. Chemical resistant inner and outer layered gloves must also be worn. Compatibility charts should be consulted to determine the appropriate type of boot and gloves to use, since no one material presently provides protection against all known chemicals. Wearing multiple layers of gloves impairs dexterity and makes performing basic aspects of patient assessment (e.g., checking breathing, taking a pulse) difficult without constant practice.

The effectiveness of CPC can be reduced by three actions: degradation, permeation, and penetration. *Chemical degradation* occurs when the characteristics of the material in use are altered through contact with chemical substances or aging. Examples of degradation include cracking and brittleness, and other changes in the structural characteristics of the garment. Degradation can also result in an increased permeation rate through the garment.

*Permeation* is the process by which chemical compounds cross the protective barrier of CPC because of passive diffusion. The rate at which a compound permeates CPC is dependent on factors such as the chemical properties of the compound, the nature of the protective barrier in the CPC, and the concentration of the chemical on the surface of the protective material. Most CPC manufacturers provide charts on the breakthrough time the time it takes for a chemical to permeate the material of a protective suit for a wide range of chemical compounds.

*Penetration* occurs when there is an opening or a puncture in the protective material. These openings can include unsealed seams, buttonholes, and zippers. Often such openings are the result of faulty manufacture or problems with the inherent design of the suit.

Protective clothing is available in a wide assortment of forms, ranging from fully-encapsulated body suits to gloves, hard hats, earplugs, and boot covers. CPC comes in a variety of materials, offering a range of protection against a number of chemicals. Emergency medical personnel must evaluate the properties of the chemical versus the properties of the protective material. Selection of the appropriate CPC will depend on the specific chemical(s) involved, and on the specific tasks to be performed.

## Respiratory Protection

Substantial information is available for the correct selection, training, and use of respirators. The correct respirator must be employed for the specific hazard in question. Material Safety Data Sheets (if available) often specify the type of respirator that will protect users from risks. In addition, manufacturers suggest the types of hazards against which their respirators can offer protection. OSHA has set mandatory legal minimum requirements (29 CFR (1910.134)) for respiratory protection. In addition, NIOSH has established comprehensive requirements for the certification of respiratory protection equipment.

**Personnel must be fit-tested for use of all respirators.** Even a small space between the respirator and you could permit exposure to a hazardous substance(s) by allowing in contaminated air. Anyone attempting to wear any type of respirator must be trained and drilled in its proper use. Furthermore, equipment must be inspected and checked for serviceability on a routine basis.

There are two basic types of respirators: air-purifying and atmosphere-supplying. Atmosphere-supplying respirators include self-contained breathing apparatus (SCBA) and supplied-air respirators (SAR).

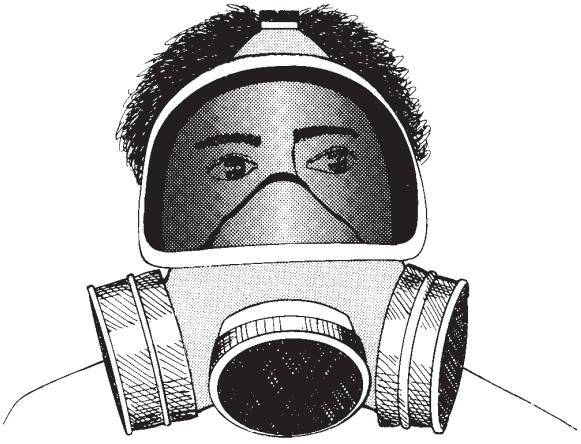
## Air-Purifying Respirators (APRs)

An air-purifying respirator purifies ambient air by passing it through a filtering element before inhalation. The major advantage of the APR system is the increased mobility it affords the wearer. However, a respirator can only be used where there is sufficient oxygen (19.5 percent) since it depends on ambient air to function. In addition, APRs should not be used when substances with poor warning properties are known to be involved or, if the agent is unknown, when environmental levels of a substance exceed the filtration capacity of the canisters.

Three basic types of APRs are used by emergency personnel: chemical cartridges or canisters, disposables, and powered air-purifiers. The most commonly used APR depends on *cartridges* (Exhibit II-9) or *canisters* to purify the air by chemical reaction, filtration, adsorption, or absorption. Cartridges and canisters are designed for specific materials at specific concentrations. To aid the user, manufacturers have color-coded the cartridges and canisters to indicate the chemical or class of chemicals for which the device is effective. NIOSH recommends that use of a cartridge not exceed one work shift. However, if breakthrough of the contaminant occurs first, then the cartridge or canister must be immediately replaced. After use, cartridges and canisters should be considered contaminated and disposed of accordingly.

*Disposable APRs* are usually designed for use with particulates, such as asbestos, although some are approved for use with other contaminants. These respirators are typically half-masks that cover the face from nose to chin, but do not provide eye protection. Once used, the entire respirator is usually discarded. This type of APR depends on a filter to trap particulates. Filters may also be used in combination with cartridges and canisters to provide an individual with increased protection from particulates. The use of half-mask APRs is not generally recommended by most emergency response organizations.

**Exhibit II-9**
**Chemical Cartridge Air-Purifying Respirator**



Powered Air-Purifying Respirators (PAPRs) have the advantage of creating an improved facemask seal, thus reducing the risk of inhalation injury. Air being blown into the mask can also have a cooling affect. PAPRs come with either full facemasks or pullover hoods. Some individuals find the hooded system to be more comfortable and less claustrophobic than the mask. According to OSHA guidelines, men with beards can wear the hooded system but not the full facemask.

## Atmosphere-Supplying Respirators

Atmosphere-supplying respirators consist of two basic types: the self-contained breathing apparatus (SCBA), which contains its own air supply, and the supplied-air respirator (SAR), which depends on an air supply provided through a line linked to a distant air source. Exhibit II-10 illustrates an example of each.

**Exhibit II-10**
**Self-Contained Breathing Apparatus and Supplied-Air Respirators**

### *Self-Contained Breathing Apparatus (SCBA)*

A self-contained breathing apparatus respirator is composed of a facepiece connected by a hose to a compressed air source. There are three varieties of SCBAs: open-circuit, closed-circuit, and escape. Open-circuit SCBAs, most often used in emergency response, provide clean air from a cylinder to the wearer, who exhales into the atmosphere. Closed-circuit SCBAs, also known as rebreathers, recycle exhaled gases and contain a small cylinder of oxygen to supplement the exhaled air of the wearer. Escape SCBAs provide air for a limited amount of time and should only be used for emergency escapes from a dangerous situation. One disadvantage of SCBAs is that they are bulky and heavy, and can be used for only the period of time allowed by air in the tank.

The most common SCBA is the open-circuit, positive-pressure type. In this system, air is supplied to the wearer from a cylinder and enters the facepiece under positive pressure. In contrast to the negative-pressure units, a higher air pressure is maintained inside the facepiece than outside. This affords the SCBA wearer the highest level of protection against airborne contaminants since any leakage in the facepiece may force the contaminant out. When wearing a negative-pressure-type apparatus, there is always the potential danger that contaminants may enter the facemask if it is not properly sealed. The use of a negative-pressure SCBA is prohibited by OSHA under 29 CFR (1910.120(q)(iv)) in incidents where personnel are exposed to hazardous materials.

### *Supplied-Air Respirators (SARs)*

Supplied-air respirators differ from SCBAs in that the air is supplied through a line that is connected to a source away from the contaminated area. SARs are available in both positive- and negative-pressure models. However, only positive-pressure SARs are recommended for use at hazardous materials incidents. One major advantage the SAR has over the SCBA device is that it allows an individual to work for a longer period. In addition, SARs are less bulky than the SCBAs. By necessity, however, a worker must retrace his steps to stay connected to the SAR, and therefore cannot leave the contaminated work area by a different exit. SARs also require the air source to be in close proximity (within 300 feet) to the work area. In addition, personnel using an SAR must carry an immediately operable emergency escape supply of air, usually in the form of a small, compressed air cylinder, for use in case of an emergency.

## Site Control

Hazardous materials incidents often attract large numbers of people and equipment. This complicates the task of minimizing risks to humans, property, and the environment.

An Incident Command System (ICS) coordinates management of facilities, equipment, personnel, and communications during a hazardous materials incident. An Incident Commander (IC) is responsible for control of the scene and for keeping contaminants on site. This includes delineating work zones, establishing levels of protection, and implementing decontamination activities.

To enhance control at the site of a chemical incident, rules regarding access to the site must be implemented. Inactive individuals and equipment should be kept at a safe distance from the area of possible contamination, and public access from all directions must be restricted promptly.

In addition, media access should be limited to an area established as the Public Information Sector by a designated Public Information Officer. All access to the incident site must be approved by the Incident Commander and the press personnel who enter the site must be escorted by a Public Information Officer.

### Work Zones

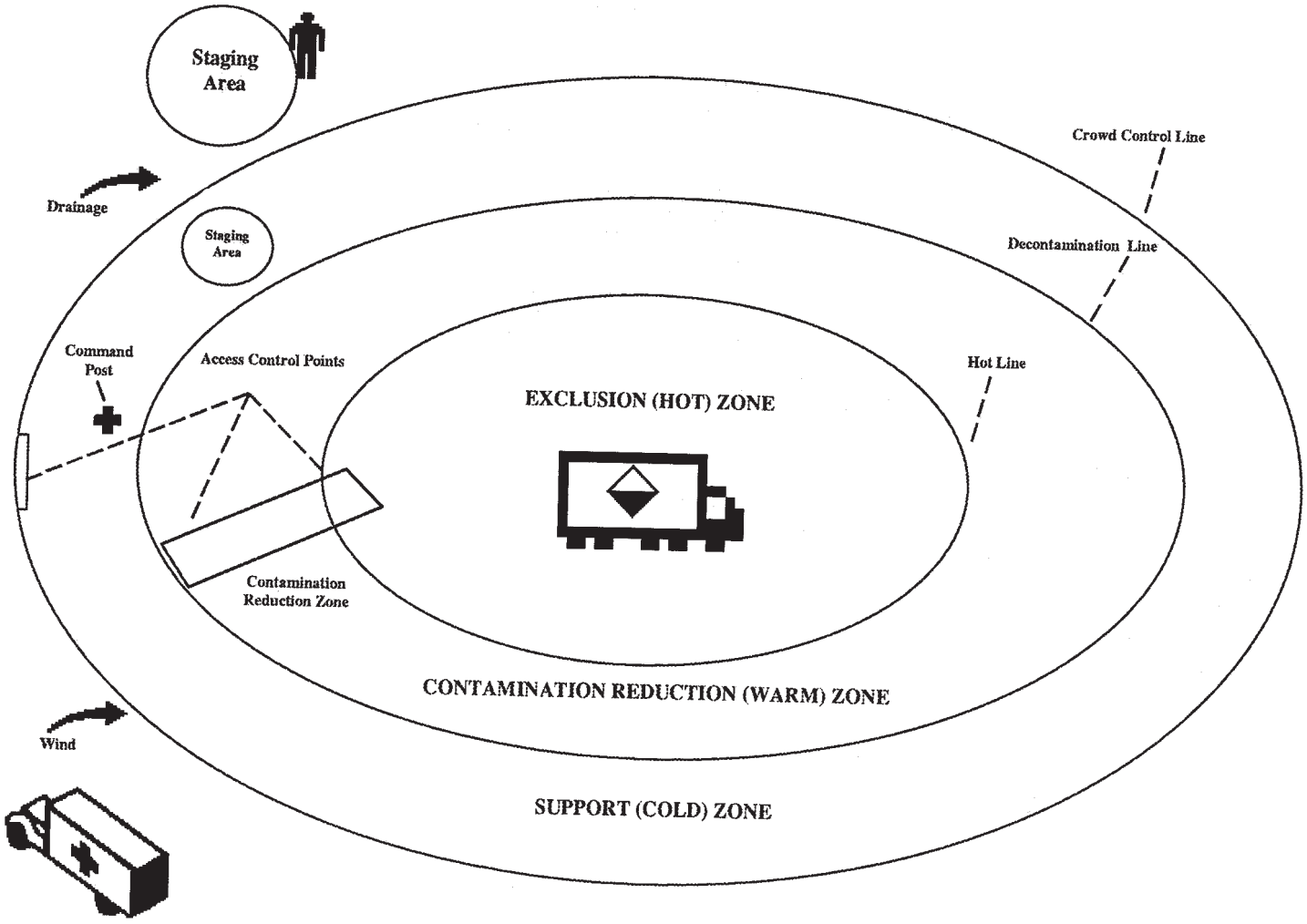
NIOSH, OSHA, USCG, and EPA recommend dividing the incident area into three zones, establishing access control points, and delineating a contamination reduction corridor. Exhibit II-11 illustrates the recommended zones. The Exclusion (Hot) Zone should encompass all known or suspected hazardous materials contamination. The respective radius of the Contamination Reduction (Warm) Zone is determined by the length of the decontamination corridor, which contains all of the needed decontamination stations. The Support (Cold) Zone should be clean, meaning it is free of all hazardous materials contamination, including discarded protective clothing and respiratory equipment. The command post and staging areas for necessary support equipment should be located in the Support Area, upwind and uphill of the Exclusion Zone. Personnel in charge of each sector should be easily recognized (e.g., with a command vest). Equipment that may eventually be needed should be kept in staging areas beyond the crowd control line. Access to the different zones should be tightly controlled and limited to as few people as possible. Communication between work areas should be face-to-face whenever possible. Use of radios or other electronic devices (e.g., bullhorns) may be restricted depending on the hazards involved.

## Decontamination of Emergency Medical Service Personnel

Decontamination is the process of removing or neutralizing harmful materials that have gathered on personnel and/or equipment during the response to a chemical incident. 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. Decontamination is of the utmost importance because it:

- Protects all hospital personnel by sharply limiting the transfer of hazardous materials from the contaminated area into clean zones.
- Protects the community by preventing transportation of hazardous materials from the hospital to other sites in the community by secondary contamination.
- Protects workers by reducing the contamination and resultant permeation of, or degradation to, their protective clothing and equipment.
- Protects other patients already receiving care at the hospital.

## Exhibit II-11
## NIOSH/OSHA/USCG/EPA Recommended Zones



This section only addresses the steps necessary for dealing with worker decontamination. Patient decontamination is addressed in Section III, *Response and Patient Management*. It should be stressed that to carry out proper decontamination, personnel must have received at least the same degree of training as required for workers who respond to hazardous materials incidents. The design of the decontamination process should take into account the degree of hazard and should be appropriate for the situation. For example, a nine-station decontamination process need not be set up if only a bootwash station would suffice.

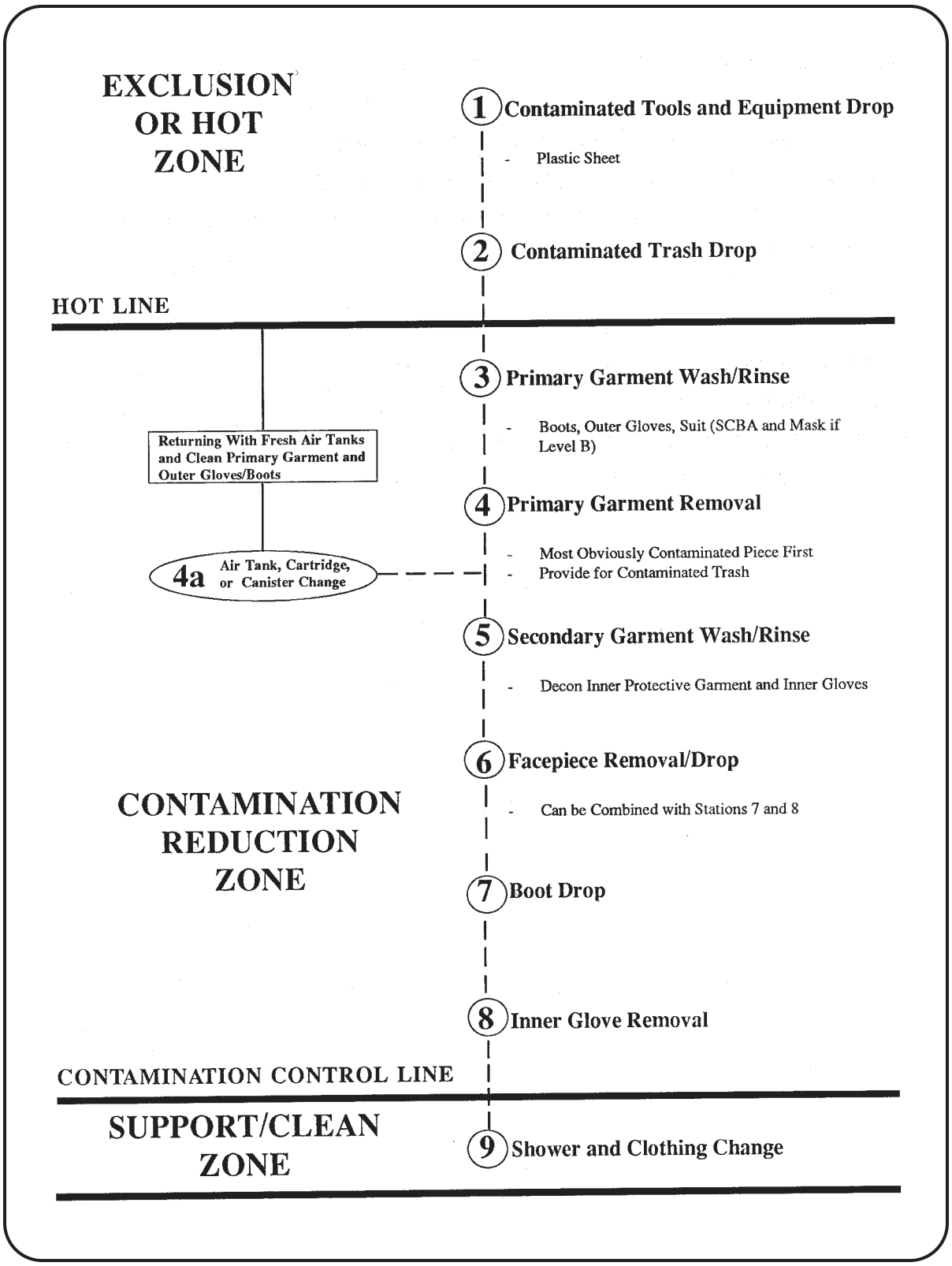
Avoiding contact is the easiest method of decontamination that is, not to get the material on the worker or his protective equipment in the first place. However, if contamination is unavoidable, then proper decontamination and/or disposal of the worker s outer gear will be necessary. Segregation and proper placement of the outer gear in a polyethylene bag or steel drum will be necessary until thorough decontamination is completed. With extremely hazardous materials, it may be necessary to dispose of the contaminated items altogether.

Physical decontamination of protective clothing and equipment (known as technical decontamination) can be achieved by several different means. These all include the systematic removal of contaminants by physical methods, such as dilution, brushing, scraping, and vacuuming, and by chemical methods where the contaminant is degraded, neutralized, solidified, or disinfected through some type of chemical process. There is an increasing trend toward using disposable clothing (e.g., suits, boots, gloves) and systematically removing these garments in a manner that precludes contact with the contaminants. The used items of clothing are then thrown away in a sealed container. Reusable suits will require thorough cleaning and testing after each use. The appropriate decontamination procedure will depend on the contaminant and its physical properties, and on the type of CPC being worn. Thoroughly researching the chemicals involved and their properties, or consultation with an expert, is necessary to make these kinds of decisions.

In addition to understanding the technical decontamination steps to be used for CPC and equipment, EMS responders must be familiar with the emergency procedures to be followed if a responder wearing PPE becomes ill or is injured and needs to be quickly decontaminated prior to normal removal of his suit.

Care must be taken at all times to ensure that the decontamination methods being used do not introduce fresh hazards into the situation. In addition, the residues of the decontamination process must be treated as hazardous wastes. The decontamination stations and process should be confined to the Contamination Reduction Zone (see Exhibit II-11). Steps for personnel decontamination are outlined in Exhibit II-12, and the technical decontamination process is discussed below.

**Exhibit II-12**
**Nine-Step Personnel Decontamination Plan**



**Technical Decontamination Process for EMS Personnel**

*Personnel should remove protective clothing in the following sequence.*

1. **Remove tape (if used) securing gloves and boots to suit.**
2. **Remove outer gloves, turning them inside out as they are removed.**
3. **Remove suit, turning it inside out and folding it downward. Avoid shaking.**
4. **Remove boot/shoe cover from one foot and step over the clean line. Remove other boot/shoe cover and put that foot over the clean line.**
5. **Remove mask. The last person removing his/her mask may want to wash all masks with soapy water before removing his/her suit and gloves. Place the masks in plastic bag and hand the bag over the clean line for placement in second bag held by another staff member. Send bag for decontamination.**
6. **Remove inner gloves and discard them in a drum inside the dirty area.**
7. **Secure the dirty area until the level of contamination is established and the area is properly cleaned.**
8. **Personnel should then move to a shower area, remove undergarments and place them in a plastic bag. Double-bag all clothing and label bags appropriately.**
9. **Personnel should shower and redress in normal working attire and then report for medical surveillance.**

## COMMUNICATIONS

Effective communications are essential to maintaining incident control. These include a dedicated radio frequency and a sufficient number of radios for distribution to all participating agencies. Another network should link the onsite command post to support groups, such as the regional Poison Control Center, the Health Department, and CHEMTREC. Other networks that may have to be activated include one linking EMTs to the hospital emergency department or medical control and one dedicated for use by the teams in the Exclusion and Contamination Reduction Zones. If a sufficient number of radios are not available or cannot be used in the Exclusion Zone, then line of sight must be maintained at all times for personnel in those Zones. Use of whiteboards, PA systems, or designated hand signals may be useful alternatives. When an Incident Command System is activated, one person should be assigned to manage communications.

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An EMS protocol for responding to potential hazardous materials incidents should consider: (1) activities to undertake en route and upon arrival at the scene; (2) guidelines for assessment, decontamination, and treatment of affected persons; and (3) patient transport to the hospital. Steps in the protocol must be practiced before a hazardous materials emergency occurs. EMS personnel should know their responsibilities and how to perform them, and all required equipment should be readily accessible and ready to use.

## En Route to a Hazardous Materials Scene

First responders must be alert for hazardous materials when responding to every call. The dispatcher may provide information such as unusual signs and symptoms (e.g., pungent odor, eye irritation) or the address might suggest that the call may involve a chemical release. The presence of hazardous materials may be obvious, as in the case of noxious fumes, gasoline, or corrosive liquid spills. In other situations, the hazardous nature of the chemical(s) may not be immediately apparent, as with odorless but poisonous and/or flammable vapors and liquids, or radioactive materials. If a vehicle has a diamond-shaped placard or an orange-numbered panel on the side or rear, the cargo should be assumed to be hazardous. Unfortunately, not all hazardous materials transport vehicles are clearly marked. Many delivery trucks regularly carry hazardous materials that could be released in a collision, yet the appropriate signage is often missing. Therefore, first responders should use caution when attempting rescues at any incident scene. The hazard, or lack thereof, must be determined immediately before first responders enter a chemically contaminated area.

While in transit to an incident scene, the responder should pay attention to clues that suggest the possibility of hazardous materials. For example, billowing smoke or clouds of vapor could indicate the presence of a dangerous substance(s). The senses are among the best tools for detecting chemicals, particularly the sense of smell. Should an odor be detected, however, responders are advised to move a safe distance away until they ascertain its source. Failure to do so could result in injury, illness, or death. Despite their value, sensory signals, such as smell, color, and nasal or eye irritation, are not always reliable indicators. Their presence depends on the chemical(s) involved and on the surrounding conditions. The nature of an incident is also key to identifying the possibility of hazardous materials. Accidents involving railroad tank cars or tanker trucks, or incidents at fixed locations where chemicals are used or stored, often indicate the presence of hazardous materials.

Emergency responders should pay attention to factors such as wind direction and topography when approaching a suspected hazardous materials incident and advance upwind and upgrade of suspected chemical emissions. They also need to consider that low-lying areas such as streambeds and gulleys, or in urban areas places such as courtyards or near tall buildings, may contain vapor clouds protected from dispersal by the wind.

Responders should attempt to gather as much information as possible while traveling to an incident. A checklist to help determine initial actions should be developed and made available to all EMS personnel. It should include:

- Type and nature of incident
- Caller s telephone number
- Knowledge of whether a chemical(s) may be involved
- Chemical and trade name(s) of substance(s) involved
- Number and ages of victims
- Signs and symptoms being experienced by the patients
- Nature of injuries
- State of the material (solid, liquid, gas)
- Routes of exposure (inhalation, dermal contact, etc.)
- Length of exposure

Using as much information as can be gleaned en route, emergency responders should relay their observations to a predesignated resource center (e.g., regional Poison Control Center, ATSDR) for information regarding definitive care procedures. If a hazardous substance has been identified, responders should locate specific information on the chemical(s) by consulting reference guidebooks, websites, database networks, telephone hotlines, MSDSs, and the DOT s *North American Emergency Response Guidebook,* in addition to the designated resource center (see Section I Hazard Recognition). Chemical-specific information can help identify possible health hazards, including: (1) the nature of possible injuries; (2) potential routes of exposure; (3) risk of secondary contamination; (4) required PPE; (5) the need for decontamination; (6) decontamination procedures; and (7) the appropriate safe distance from the hazard to protect EMS personnel, the public, and property from exposure to contaminants or other dangers such as fire or explosion. If available, preplans should be reviewed to assist with locating proper vehicle staging locations, evacuation routes, and patient treatment centers. This information may also be available from a command post, if one has been established.

Communications with other agencies or services should also be initiated while en route to the event site. If an Incident Command System (ICS) has been implemented, the Incident Commander (IC) will identify the best approach route, the possible dangers involved, and the estimated number of injuries. Communications between onsite response personnel and receiving facilities should be kept open to relay as much advance information as possible. Communications should also be established with local fire and police departments, and with the hazmat response team, if appropriate.

## Arrival at the Scene

Many first responders (e.g., police officers, the fire-rescue squad, EMS personnel) are accustomed to immediately attending an injured victim, often disregarding the possibility of danger to themselves. In such cases, a rescuer entering a contaminated area also risks exposure and the potential to become another victim. Even though rescue of an injured patient is important, it should only be attempted without undue risk to the responder(s). While training and experience are valuable in these situations, often these types of decisions are, at best, a judgment call. Rescue should only be attempted by trained and equipped EMS, fire department, or hazardous materials response team personnel. Exhibit III-1 illustrates a typical decision tree for making choices about risk and response.

Upon arrival at a scene, an initial assessment of the nature and extent of the incident should be conducted and additional support requested, if necessary. A first-in responder should also confirm that local authorities have been notified and are aware that hazardous materials might be involved. Onsite assistance should include police, fire, and health departments; the hazmat response team(s); and the local industry response team(s). Unless otherwise directed, responders should park at a safe distance that is upwind, upgrade, and pointing away from any incident where hazardous materials are suspected. Safe distances for specific chemicals may be determined from the DOT s *North American Emergency Response Guidebook,* or by consulting CHEMTREC or other written or electronic references. Responders must also remain alert to the possibility that the incident is the result of an intentional criminal act, with the presence of secondary devices intended to injure emergency personnel.

General guidelines for responders include:

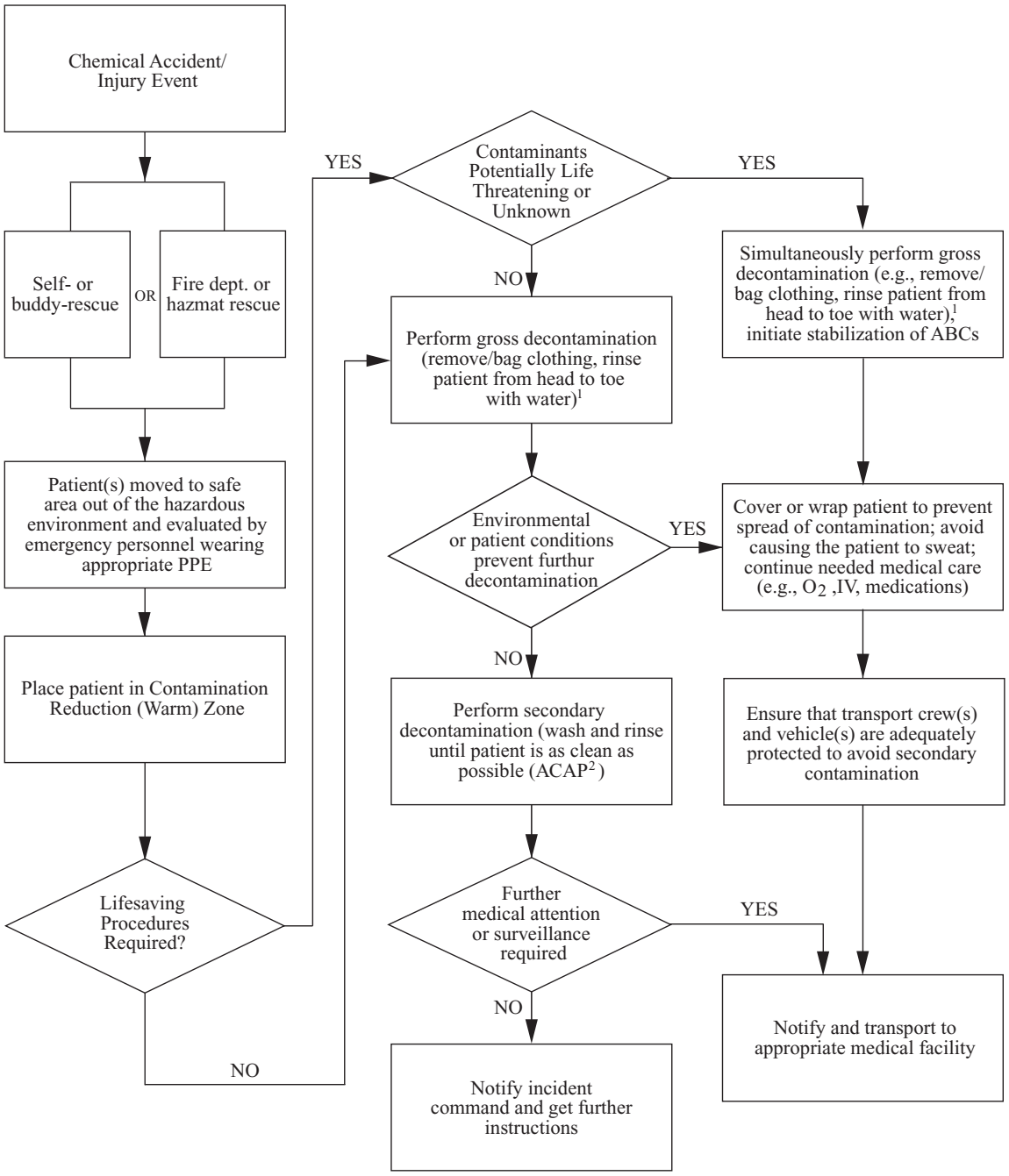
- Do not drive or walk through any spilled or released materials, including smoke, vapors, and puddles.
- Avoid unnecessary contamination of equipment.
- Do not attempt to recover shipping papers or manifests unless adequately protected.
- Avoid exposure while approaching a scene.
- Do not approach anyone coming from contaminated areas.
- Do not attempt rescue unless trained and equipped with appropriate PPE for the situation.
- Report all suspicious packages, containers, or people to the command post.

The first units to arrive at a large industrial or storage facility, transportation accident, or a mass gathering location should anticipate a rush by evacuating victims. Proper steps must be taken to keep responders from becoming contaminated or otherwise harmed (e.g., use of a PA system to give instructions).

**The top priority for first responders is scene isolation.** Keep others away! Keep unnecessary equipment from becoming contaminated by giving exact information on safe routes of arrival and vehicle staging locations, and by reporting anything suspicious.

First responders should immediately establish an Exclusion (Hot) Zone, taking care not to become exposed during the process (see Exhibit II-11). The Exclusion Zone should encompass all contaminated

## Exhibit III-1
## Sample EMS Decision Tree for Chemical Incidents




[1] No patient should be transported without a minimum of gross decontamination performed.

[2] Contamination reduced to a level that is no longer a threat to patient or responder (once achieved, move patient to the Support [Cold] Zone).

areas, and no unauthorized personnel should be allowed to enter that Zone. Anyone leaving the Exclusion Zone should be considered contaminated, requiring assessment and possible decontamination. Additional zones, including a Contamination Reduction (Warm) Zone and a Support (Cold) Zone, should be delineated at the first available opportunity. Depending upon available personnel, this may be the primary responsibility of the Incident Commander (IC) or of responders other than EMS. *Do not remove nonambulatory patients from the Exclusion Zone unless properly trained personnel with the appropriate PPE are available and a decontamination corridor has been established.* The IC should coordinate patient evacuation and emergency care activities. A public address system (e.g., bullhorn, siren PA system) can be effective for directing ambulatory patients on what to do and where to go.

EMS responders who are not properly trained and equipped should stay out of the Exclusion and Contamination Reduction Zones. While it is recommended that all EMS personnel be trained and equipped to work (at a minimum) in Level C PPE protective attire (see Section II), this does not provide maximum skin or respiratory protection. Entry into a Hot or Warm Zone requires a determination that the level of PPE being worn affords adequate protection.

In addition to providing patient care in the Support Zone, qualified EMS personnel may be asked to assume any of the following roles: Safety Officer, EMS Section Officer (e.g., Triage, Treatment, Transportation, Communications), Rehabilitation Officer, or Public Information Officer. EMS personnel also frequently provide medical surveillance for the hazmat team.

## Assessment, Decontamination, and Initial Treatment of Patients

The primary goals for emergency personnel in a hazardous materials incident include cessation of patient exposure, patient stabilization, removal of the patient from danger, containment of the hazard to prevent further contamination, and patient treatment all without jeopardizing their own safety. While not all chemicals pose a hazard for secondary contamination, until the risk is known, termination of exposure is best accomplished by removing the patient from the incident area and then decontaminating the patient. If the victim is removed from the possibility of additional exposure or other dangers and is no longer considered contaminated, the level of required PPE for emergency personnel can be downgraded to a level that will better facilitate patient care. The potential for injury to the patient or to response personnel prohibits any treatment other than basic life support inside the Exclusion Zone. The dangers of hazardous substances, fire, or explosion, as well as the mobility restrictions inherent in PPE, outweigh the benefits of time saved by patient care in the Hot Zone.

The essential requirements for any decontamination task are:

- A safe area to keep a patient while undergoing decontamination
- A method for washing contaminants off a patient
- A means of containing the rinsate
- Adequate protection for personnel treating the patient
- Disposable or cleanable medical equipment to treat the patient

## Gross Patient Decontamination

Primary assessment can be undertaken while simultaneously performing gross decontamination in the outer edge of the Exclusion Zone or in the Contamination Reduction Zone. **Priority should be given to the fundamentals of emergency treatment airway, breathing, and circulation (ABCs).** Once life-threatening matters have been addressed, rescue personnel can direct their attention to more thorough decontamination and secondary patient assessment. Appropriate personal protective equipment and clothing must be worn until the threat of secondary exposure no longer exists. The sooner the patient is decontaminated, the sooner he or she can be transferred to the Support Zone for further evaluation and treatment.

If there is a risk of secondary contamination, gross decontamination should be performed simultaneously with initial patient stabilization. This consists of cutting away or otherwise removing all potentially contaminated clothing, including jewelry and watches. All removed items should be doubled-bagged in plastic bags, sealed, and labeled. Any obvious contamination should be brushed or wiped off, followed by a 1-minute-long rinsing from head to toe with tepid water. If the suspected chemical is water-reactive, a longer rinsing period and a greater volume of water is required. Care should be taken to protect any open wounds from contamination by covering them with a water-repellent dressing (e.g., Chux). Throughout these procedures, every effort should be made by emergency personnel to avoid contact with any potentially hazardous substance(s).

## Secondary or Definitive Decontamination

Effective decontamination consists of making the patient As Clean As Possible (ACAP). If conditions permit (appropriate personnel, supplies, water, weather), a more deliberate decontamination process known as secondary or definitive decontamination should be initiated on each patient before transfer into the Support Zone. This process includes washing the individual, usually with soap and water, in an organized and thorough manner. Initiating this step implies that contamination has been reduced to a level that is no longer a threat to the patient or to the responder. Determining the adequacy of decontamination can be very difficult, however, and is often based on a best clinical judgment rather than on objective data. Detection monitors (to indicate how clean an area is) have limited value and are not generally available to most fire departments or EMS agencies. When a patient cannot be definitively decontaminated, then he or she should be loosely wrapped in a cocoon-like fashion with a blanket or sheet prior to transfer to the Support Zone.

Exhibit III-2 outlines the minimum equipment that is required for patient decontamination by emergency response personnel. These lists are not comprehensive, and are provided to guide departments in developing their own equipment lists based on community needs and requirements.

With few exceptions, intact skin is more resistant to hazardous materials than injured flesh, mucous membranes, or eyes. Therefore, secondary decontamination should begin at the head and proceed downward, with initial attention paid to contaminated eyes and open wounds. Once wounds have been cleaned, care should be exercised not to recontaminate them. This can be aided by covering the wounds with a waterproof dressing. For some chemicals, such as strong alkaline substances, it may be necessary to flush exposed skin and eyes with water or normal saline for a minimum of 15 minutes.

**Exhibit III-2**
**Suggested Decontamination Equipment**

The equipment and supplies listed are the minimum necessary to undertake decontamination procedures. In addition, PPE used by decontamination personnel should be no less than one level below that used for entry into the hazardous environment. Positive-pressure self-contained breathing apparatus (SCBA) and fully-encapsulated suits may be necessary in extreme cases.

- Containment equipment
  - Pool or tank
  - Tarps
  - 6-mil construction plastic
- Fiberglass backboards
- Supports for ambulatory patients
- Sawhorses to support backboards
- Water supply
- Scissors for clothing removal
- Mild detergent (dishwashing liquid)
- Five-gallon buckets
- Sponges and soft brushes
- Towels and blankets
- Disposable clothes and shoes for ambulatory patients
- Large plastic bags for contaminated clothing with predetermined unique ID tags to go on the bag and patient wrist/neck
- Small plastic bags for patients valuables (clear freezer bags are preferable)
- Tags and waterproof pens to mark bags
- Clear, zip-front body suits or large water repellant blankets to minimize contamination to transport personnel and ambulances
- Tape (duct, 4-inch)
- Triage tags

Washing should be done using warm water, soft bristle brushes or sponges, and a mild soap, such as dishwashing liquid. Hot water, stiff brushes, and vigorous scrubbing should seldom be used because they cause vasodilation, abrasion, and increased entry of toxicants through the skin. The skin of young children is particularly sensitive and should be treated accordingly. Responders should try to contain all run-off from decontamination procedures for proper disposal. Whenever possible, men and women should be provided separate treatment areas. Allowing ambulatory patients to decontaminate themselves under supervision may accelerate the process and reduce the need for response personnel. In such cases, it may be necessary to provide instructions in multiple languages, preferably using a prerecorded message, to assure that patients understand the problem and follow instructions. Patient compliance with clothing removal and decontamination instructions will likely be influenced by their perception of the threat to their life and health, as well as by the clarity and authoritative nature of the instructions given.

Decontamination of nonambulatory patients is more difficult and labor-intensive. Careful attention must be paid to cleaning the back, buttocks, axilla, hair, and genitalia. The backboard and collar

along with any other medical equipment used to transport the patient must either be decontaminated or exchanged prior to the individual entering the Support Zone. If a patient is seriously ill, ventilation support and the administration of medicines may be required while he or she is undergoing decontamination. However, invasive procedures (e.g., intubation) should not be initiated in the Contamination Reduction Zone unless absolutely necessary.

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.

Many chemical substances, even though highly toxic, carry no intrinsic risk for contamination to others. Most toxic gases, such as carbon monoxide or arsine, are highly poisonous, but once the victim has been brought out of the exposure area and into the fresh air, the amount of leftover gas in and around the patient is unlikely to poison others, especially when the patient s clothes are removed. Even many chemicals that have the potential for spreading contamination can be rendered less hazardous by clothing removal and simple dilution of contaminants with copious amounts of water.

## Pediatric Decontamination Considerations

The complexity of managing a hazardous materials incident is increased when children are involved. While protective to the wearer, PPE may be frightening to a young child, resulting in less cooperation and greater psychological trauma. Whenever possible, children and parents (or other adults known to them) should remain together while undergoing decontamination, medical treatment, and transport to the hospital. Constant reassurance and compassion will be especially important if a child is separated from his or her parent(s). Efforts at reuniting parent and child should be made as early as is safely possible, either at the scene or at the hospital. Older children, while likely to be more compliant with instructions and self-sufficient during the decontamination process, may nevertheless be more susceptible to mass hysteria if not properly informed and reassured.

Increased susceptibility to hypothermia is an important consideration in determining to what degree a child is decontaminated in the field as opposed to being grossly decontaminated, wrapped in a blanket for transport, and then given definitive decontamination at the hospital or other heated location.

## Mass Population Decontamination

Certain hazmat incidents result in large numbers of patients being exposed (or believing they were exposed) to a chemical agent. In this situation, responding personnel will find it necessary to implement proper triage to prioritize patients  entry through the decontamination process, or to quickly expand the decontamination system to clean more patients simultaneously. Gaining quick control of the escaping crowd and initiating immediate decontamination procedures (if indicated) is essential to minimize secondary contamination, morbidity, mortality and panic. Large volumes of water from charged hose lines, and specially-mounted nozzles or deluge guns on fire engines, can be used to quickly rinse large numbers of individuals. Some fire departments or hazmat teams use portable trailers and/or aerial ladder trucks with special spray systems containing both soap and water (or bleach and water) to provide gross and/or secondary decontamination for large-scale efforts. Once through the decontamination steps, patients should be given towels, temporary clothing (e.g., a plain

## Decontamination

- Make sure all clothing is removed.
- Brush or vacuum particulate matter off of skin.
- Decontaminate systematically from the head down with water:
  - Water-wash contaminated area gently under a stream of water, and scrub with a soft brush or surgical sponge along with soap
  - Limit mechanical or chemical irritation of the skin by overzealous scrubbing or forceful water flow
  - Use warm, never hot, water
  - Decontaminate exposed wounds and eyes before intact skin areas
  - Cover wounds with a waterproof dressing after decontamination
  - Take care not to introduce contaminants into open wounds
  - Remember the back, under skin folds and genitalia
  - Watch for any changes in the patient s condition
- Remove contaminants to the level that they are no longer a threat to the patient or response personnel, or as far as the situation or their clinical condition allows.
- Isolate the patient from the environment by wrapping in blanket/sheet to prevent the spread of any remaining contaminants.
- If possible, contain all runoff from decontamination procedures for proper disposal.
- Ensure that all potentially contaminated patient clothing and belongings have been bagged and tagged:
  - Properly label the bags that contain clothing or other potentially contaminated articles
  - Consult with proper officials (e.g., Safety Officer, Hazmat Officer) regarding disposition of bags containing patient valuables

Tyvek suit with hood, booties, and gloves), and a blanket, and then directed to the Treatment Sector for evaluation. Mass decontamination planning should also address issues such as non-English-speaking patients, caring for physically impaired patients (e.g., nonambulatory, blind, wheelchair-bound), and large numbers of worried but well victims.

## Considerations for Patient Treatment

In most aspects, a contaminated patient is like any other patient except that responders must protect themselves and others from dangers due to secondary contamination. Response personnel must first address life-threatening issues and gross decontamination before taking supportive measures. If spinal immobilization appears necessary, it should be initiated as soon as feasible. Primary surveys should be accomplished simultaneously with decontamination, and secondary surveys completed as conditions allow. In treating patients, personnel should consider the chemical-specific information received from the Poison Control Center and other information resources. In multiple patient situations, proper triage procedures should be implemented using local emergency response plans (see Section I SARA Title III).

**Patient Treatment**

- Assign highest priorities to ABCs and decontamination.
- Complete primary and secondary surveys as conditions allow. Bear in mind the chemical-specific information received from the designated poison control or medical control center.
- Treat for spinal injury, if indicated.
- In multiple patient situations, begin proper triage procedures.
- Administer antidotes and dosages per local protocol.
- Delay prophylactic measures until the patient is decontaminated.
- Perform invasive procedures only in uncontaminated areas.
- Reassess the patient frequently because many chemicals have latent physiological effects.

The patient should undergo frequent reassessments because many hazardous materials have latent physiological effects. Unless required by life-threatening conditions, prophylactic invasive procedures, such as intravenous injections or intubation, should be performed only in fully decontaminated areas and where conditions permit because they may create a direct route for introducing hazardous material(s) into the patient. Oxygen should be given using a bag valve mask with reservoir device (rebreather) or with a manually triggered oxygen-powered breathing device. Oxygen bottles and regulators should be encapsulated in plastic to facilitate decontamination, and every effort should be made to avoid mixing contaminated air with the oxygen. Caution must also be exercised when dealing with patients who are vomiting; off-gassing of a product or absorption through the skin or mucous membranes can occur from the emesis in some cases.

While some contaminated patients may require treatment with antidotes, most cases can be handled with symptomatic care. Antidote administration should be based on patient condition, antidote availability, and proximity to the hospital. Emergency personnel must have a thorough understanding and familiarity with authorized antidotes since they can have significant side effects. Medication dosing for children must be carefully checked because they are most often administered on a mg/kg basis, and therapeutic and toxic levels can be very close. Exhibit III-3 lists frequently used antidotes and selected other pharmacologic treatment agents.

**Exhibit III-3**
**Antidotes and Select Pharmacologic Treatment Agents**

| Antidote | Toxicant |
|---|---|
| Atropine[1] | Organophosphate pesticides and nerve agents |
| Pralidoxime chloride (2-PAM Chloride)[1] | Organophosphate pesticides and nerve agents |
| Cyanide antidote kit | Cyanide |
| Methylene blue 1% | Methemoglobinema |
| Activated charcoal | Certain ingested substances |
| Calcium gluconate (Gel and IV) | Hydrofluoric acid and fluoride toxicity |
| Oxygen | Carbon monoxide |

[1] Can be found combined in auto-injection kit known as Mark I.

## Patient Transport to the Hospital

When transporting a contaminated patient (i.e., only gross decontamination performed) by ambulance, special care should be exercised to prevent contamination of the vehicle and subsequent patients. Exposed surfaces that the patient is likely to contact should be protected by disposable sheeting. The use of both chemically resistant backboards and disposable sheeting are highly recommended. If a wooden backboard is used, it should be wrapped in a disposable cover or it may have to be discarded. Unnecessary equipment should be stored in a safe location or removed; equipment that does come in contact with the patient should be segregated for decontamination or disposal.

Exhibit III-4 outlines suggested equipment for the care and transport of contaminated patients. Items should be added or deleted based on local needs and experience.

The patient should be as clean as reasonably possible before transport, and further contact with contaminants should be avoided. **No patient should be transported who has not, at a minimum, undergone gross decontamination.** Protective clothing should be worn by response personnel, as appropriate. 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. Body bags are not recommended for encapsulating patients for physiological and mental health reasons. Consideration should also be given to chemicals that present the added danger of accelerated skin absorption due to heat. The name(s) of the involved chemicals, if identified, and any other data available, should be recorded before leaving the scene. Oxygen should be administered by rebreather mask for any victim with respiratory problems unless contraindicated (e.g., end-stage chronic obstructive pulmonary disease (COPD)). Eyes that have been exposed should be irrigated with available saline or water, and irrigation should be continued en route to the hospital. Personnel should also be alert for any signs of respiratory distress, cardiovascular collapse, or gastrointestinal complaints. Seizures may occur and should be treated according to local protocol. Patients experiencing pain as a result of their injuries should be treated per medical control or agency protocol. Various types and degrees of burns may be seen and should be treated per local burn protocol or Burn Center instructions. In the case of acid and alkaline burns to the eyes, they should be continuously irrigated en route to the hospital. Control and proper disposal of the run-off is necessary to avoid injury to the patient and prehospital caregiver(s). Verbal reassurances and other forms of psychological support will also be important to minimize further fear and anxiety.

During transport, ambulance personnel should use appropriate respiratory protection. 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.

Contact the receiving hospital and provide an update on treatment provided or required and any other pertinent clinical information. Instructions for the procedure to enter the hospital with a contaminated patient should also be requested. Facilities receiving a potential hazardous materials patient will need as much information as possible, as soon as possible.

## Exhibit III-4
## Supplies Needed to Prepare the Ambulance for Care of a Patient Contaminated with Hazardous Materials

- Sufficient 6-mil construction plastic[1] cut to size to:
  - Cover floor of ambulance
  - Cover squad seat
  - Cover litter
- Disposable sheet(s)
- Plastic trash bags to contain contaminated medical supply waste, gloves and the victim s clothes, and vomitus
- Personal Protection:
  - CPC disposable suits with built-in hoods and booty/boot covers
  - Positive-pressure SCBA[2]
  - Full-facemask respirator with an orange- and purple-type cartridge (acid gas, organic vapor, highly toxic dust, mist and fumes, and radionuclides-rated, HEPA cartridge)[2]
  - Polyvinyl chloride (PVC) or duct tape for taping closures
  - Two-piece rainwear
  - Rubber boots with steel toes
  - Nitrile gloves with 14-inch cuffs
  - Duct tape to seal suit seams, if necessary

[1] Wet plastic is slippery; stability is important.

[2] Must not be used without prior training and fit testing.

NOTE: The protective equipment listed is to be used for patient care situations after initial decontamination. It is meant to be used when complete decontamination of the patients cannot be guaranteed or when assisting with decontamination procedures (in extreme cases positive-pressure SCBA and encapsulated suites may be required for decontamination procedures). **It is not meant to be used in rescue operations of victims found in a hazardous area.** Under no circumstances should this equipment be relied upon for entry into hazardous environments. Protective equipment for entry must be appropriate to and compatible with the products involved. This may include positive-pressure SCBA and fully encapsulated suits. Many factors must be taken into consideration when determining the appropriate level of protection. Consequently, selection of protective equipment must be done by a qualified individual.

A radio report checklist should be developed and made available for all vehicles and telephone or radio communication centers. This information will aid in initiating appropriate actions:

- Type and nature of incident
- Number and ages of patients
- Signs and symptoms being experienced by the patients
- Nature of injuries
- Name of chemical(s) involved, including trade names
- Information available at the site concerning the chemical(s), including the MSDSs
- Extent of patient decontamination in the field
- Estimated time of arrival

The ambulance should park in an area away from the emergency room or go directly to a predesignated decontamination location, thereby limiting exposure to hospital facilities. To protect hospital staff and other patients, the victim should not be brought into the emergency department before ambulance personnel receive permission from the hospital staff.

Upon release of the patient to the hospital, any nondisposable equipment that is believed to be contaminated should be double-bagged. Contaminated articles should be kept sealed until the Incident Commander or his designee gives further instructions. Whenever possible, the use of disposable equipment is recommended. Inquiries should be made at the hospital to determine where the ambulance can be safely decontaminated, and whether equipment is available for this purpose. The method of decontamination should be based on the chemical(s) involved and the extent of patient decontamination prior to transport. In most cases soap and water are adequate for vehicle decontamination. The ambulance should not go back into service until it is determined to be safe by an appropriately trained individual (e.g., a hazmat team coordinator). This again emphasizes the benefits of thorough patient decontamination prior to transport; if the patient is clean, then the vehicle s interior will also be clean.

## Transport to the Hospital

- Get patient as clean as possible prior to transport.
- Avoid contact with contaminants; provide protection to the vehicle; wear protective clothing as appropriate.
- Provide other patient care according to condition and local protocol.
- Before leaving the scene, write down the name of the involved chemical(s) and any other available data.
- Provide fresh air ventilation to the patient s and the driver s compartments.
- Contact the receiving hospital ASAP; provide information on the patient and treatment rendered; identify the chemical, its toxicology, MSDS, and any other pertinent information.
- Obtain instructions on approaching and entering the hospital.
- Have open bag ready in case of vomiting and carefully isolate vomitus since off-gassing can occur.
- Be alert for any respiratory distress; administer oxygen by mask for any patient with respiratory problems (except as contraindicated).
- Continue to irrigate eyes as needed with normal saline or water.
- Park the ambulance in a location away from the emergency department or go directly to a predesignated decontamination area.
- Do not bring patients into the emergency department before receiving permission from the hospital staff.
- After unloading the patient, check with the hospital to determine where the ambulance can be safely decontaminated, and the availability of equipment for this purpose.
- Decontaminate exposed emergency personnel.

## Air Transportation of Chemically Exposed Patients

The role of aeromedical support for hazmat incidents is limited because of the potential danger in transporting patients by helicopter from a hazardous materials site. Especially in cases involving more severe injuries, decontamination is often incomplete before removal, and as a result the flight crew risks becoming seriously ill in transit. The flight path to the site may also require their traveling through an unsafe area. Furthermore, the down draft from the helicopter can affect vapor or fume dispersion at the scene. In many areas, flight program policies specifically preclude the use of helicopters for these types of incidents.

## Critique

As soon as possible following a hazardous materials incident, all participating units should send knowledgeable representatives to meet and review the measures that were taken by each unit or agency. The purpose of this review is to examine which activities succeeded and which did not, and to evaluate the overall coordination effort with an aim toward making necessary improvements. The results of the discussion should be shared with all agency personnel. Identified weaknesses or omissions in the response plan should be corrected, and training given on new policies and procedures.

## Patient Management Under Mass Casualty Conditions Involving Hazardous Chemicals

Basic medical procedures in a large-scale hazardous materials incident are not substantially different from life-saving measures in other mass casualty disasters. Primary attention should focus on the ABC fundamentals of emergency care, with decontamination performed at the same time.

There are, however, several important differences in disasters involving hazardous materials. A hazmat disaster may require setting up mass screening and decontamination centers. It may also be necessary to establish casualty collection points to provide stabilizing care in the field prior to transport. A major chemical incident may overwhelm any one hospital, especially if it occurs along with another disaster such as an earthquake. Such an event would drastically increase the number of casualties and the complexity of the medical care that must be provided (e.g., crushing injuries or spinal trauma, combined with gas inhalation). This would require increased numbers of personnel, perhaps more sophisticated medical equipment, and a better transport system for taking stabilized victims out of the area. Training in the appropriate procedures to be followed is essential for potential responders to a hazardous materials incident involving mass casualties. Triage may also be complicated for chemical exposures associated with the delayed onset of signs and symptoms. If necessary, the patient, injured or not, must be decontaminated before being transported to the emergency department to protect EMS and emergency department staff.

## Critical Incident Stress Management

Situations involving large numbers of ill or injured individuals, and risks of harm to the responder(s), are sources of critical incident stress. To minimize the occurrence of acute or long- term psychological consequences in response personnel, stress debriefing sessions should be held shortly after the incident. Acute stress reactions recognized during and after the incident should be immediately addressed by qualified peer debriefers or other mental health professionals.

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# Appendix A

## Hazardous Materials Classification Systems

## National Fire Protection Association, 704M System

The marking system designed by the National Fire Protection Association identifies hazard characteristics of materials at terminal and industrial sites. It uses a diamond divided into four quadrants, with each quadrant representing a different characteristic, as explained below.

The risk level ratings, ranging from four (highest risk) to zero (minimum risk), are based upon protective equipment normally used by firefighters.

### Health (Blue)

Health hazards in firefighting generally result from a single exposure, which may vary from a few seconds up to an hour. Only hazards arising out of an inherent property of the material are considered. It should be noted, however, that the physical exertion demanded in firefighting or other emergency conditions tends to intensify the effects of any exposure.

**Risk level 4:** Materials too dangerous to human health to expose firefighters. A few whiffs of the vapor could cause death or the vapor or liquid could be fatal on penetrating the firefighter s normal full protective clothing. The normal full protective clothing and breathing apparatus available to the average fire department will not provide adequate protection against inhalation or skin contact with these materials.

**Risk level 3:** Materials extremely hazardous to health, but areas may be entered with extreme care. Full protective clothing including self-contained breathing apparatus, coat, pants, gloves, and boots, with bands around the legs, arms, and waist should be provided. No skin surface should be exposed.

**Risk level 2:** Materials hazardous to health, but areas may be entered freely with full facemask self-contained breathing apparatus that also provides eye protection.

**Risk level 1:** Materials only slightly hazardous to health. It may be desirable to wear self-contained breathing apparatus.

**Risk level 0:** Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.

### Flammability (Red)

Susceptibility to burning is the basis for assigning risk levels within this category. The method of attacking the fire is influenced by the material s susceptibility factor.

**Risk level 4:** Very flammable gases or very volatile flammable liquids. Shut off flow and keep cooling water streams on exposed tanks or containers.

**Risk level 3:** Materials that can be ignited under almost all normal temperature conditions. Water may be ineffective because of the low flash point.

**Risk level 2:** Materials that must be moderately heated before ignition will occur. Water spray may be used to extinguish the fire because the material can be cooled below its flash point.

**Risk level 1:** Materials that must be preheated before ignition will occur. Water may cause frothing if it gets below the surface of the liquid and turns to steam. However, water fog gently applied to the surface will cause a frothing that will extinguish the fire.

**Risk level 0:** Materials that will not burn.

## Reactivity/Stability (Yellow)

The assignment of degrees in the reactivity category is based upon the susceptibility of materials to release energy either by themselves or in combination with water. Fire exposure is one of the factors considered, along with conditions of shock and pressure.

**Risk level 4:** Materials that (in themselves) are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures. Includes materials that are sensitive to mechanical or localized thermal shock. If a chemical with this hazard rating is in an advanced or massive fire, the area should be evacuated.

**Risk level 3:** Materials that (in themselves) are capable of detonation or of explosive decomposition or reaction that require a strong initiating source that must be heated under confinement before initiation. Includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures, or that react explosively with water without requiring heat or confinement. Firefighting should be done from an explosive-resistant location.

**Risk level 2:** Materials that (in themselves) are normally unstable and readily undergo violent chemical change, but do not detonate. Includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures, or that can undergo violent chemical change at elevated temperatures and pressures. Also includes those materials that may react violently with water or that may form potentially explosive mixtures with water. In advanced or massive fires, firefighting should be done from a safe distance or from a protected location.

**Risk level 1:** Materials that (in themselves) are normally stable but that may become unstable at elevated temperatures and pressures or that may react with water with some release of energy, but not violently. Caution must be used in approaching the fire and applying water.

**Risk level 0:** Materials that (in themselves) are normally stable even under fire exposure conditions and that are not reactive with water. Normal firefighting procedures may be used.

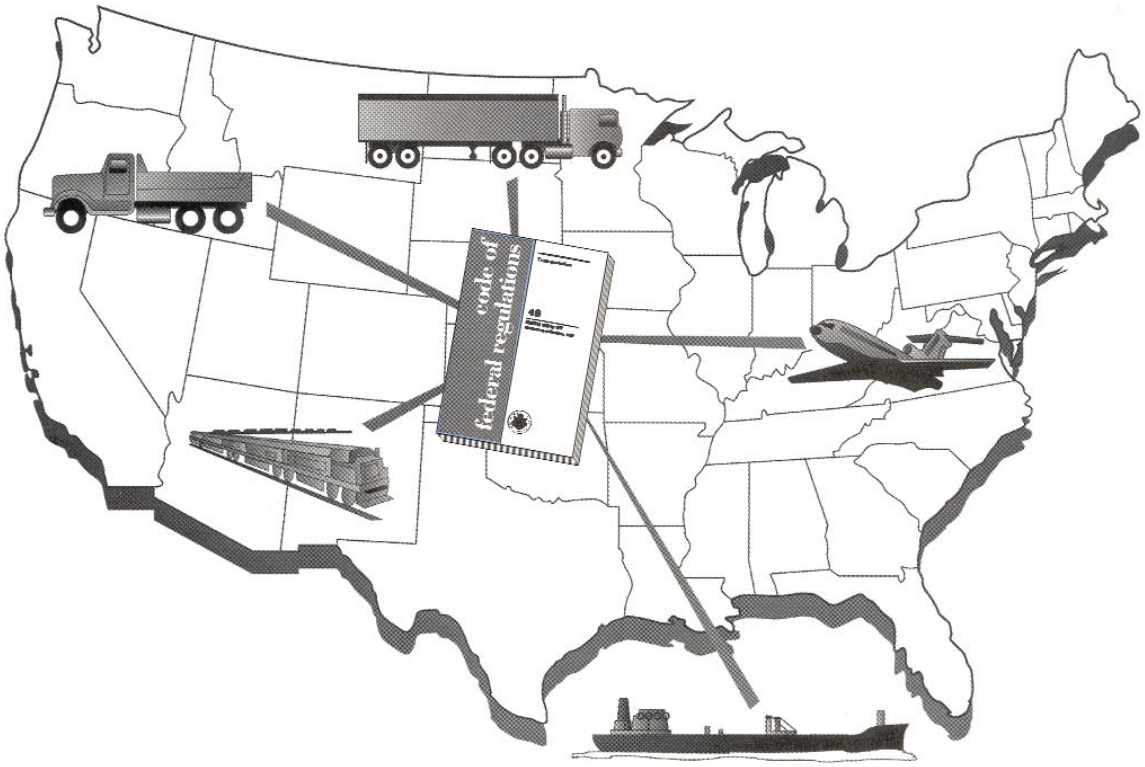
## Special Information (White)

The quadrant includes information on specific characteristics of the material (e.g., reactivity with water, tendency to oxidize).

U.S. Department of Transportation
**Research and Special Programs Administration**

# DOT CHART 11

## Hazardous Materials Marking, Labeling & Placarding Guide




Refer to 49 CFR, Part 172:

Marking - Subpart D

Labeling - Subpart E

Placarding - Subpart F

Emergency Response - Subpart G

**NOTE:** **This document is for general guidance only and must not be used to determine compliance with 49 CFR, Parts 100-185.**

# Hazardous Materials Warning Labels

CLASS 1 Explosive 1.1 1.2 1.3


*Include appropriate division number and compatibility group letter.

CLASS 1 Explosive 1.4


*Include appropriate compatibility group letter.

CLASS 1 Explosive 1.5


*Include appropriate compatibility group letter.

CLASS 1 Explosive 1.6


*Include appropriate compatibility group letter.

CLASS 2 Division 2.1


Flammable gas

CLASS 2 Division 2.2


Non-flammable gas

CLASS 2 Division 2.2


Oxygen

CLASS 2 Division 2.3


Poison gas

CLASS 3


Flammable liquid

CLASS 4 Division 4.1


Flammable solid

CLASS 4 Division 4.2


Spontaneously Combustible

CLASS 4 Division 4.3


Dangerous when wet

CLASS 5 Division 5.1


Oxidizer

CLASS 5 Division 5.2


Organic peroxide

CLASS 6 Division 6.1


Poison-Inhalation Hazard only, Zone A or B.

CLASS 6 Division 6.1


POISON
Placard 454 kg (1,001 lbs) or more of PG I or II, other than Zone A or B, inhalation hazard.

CLASS 6 Division 6.1


Poison-PG III

CLASS 6 Division 6.2


Infectious substance


29 CFR 1910.1030 BIOHAZARD marking may be used for Regulated Medical Waste (RMW).

CLASS 7


Radioactive WHITE-I

CLASS 7


Radioactive YELLOW-II

CLASS 7


Radioactive YELLOW-III

CLASS 8


Corrosive

CLASS 9


Miscellaneous

SUBSIDIARY RISK LABELS


Explosive
Flammable gas
Flammable liquid
Flammable solid
Corrosive
Oxidizer
Poison
Spontaneously Combustible
Dangerous when wet

The class number may not be displayed on a subsidiary label (see Section 172.402).

EMPTY

Empty-Radioactive

FOR AIRCRAFT


Cargo Aircraft Only


TRANSITION-2001


TRANSITION-2001


TRANSITION-2001


TRANSITION-2001


TRANSITION-2001


TRANSITION-2001


## HAZARDOUS MATERIALS MARKINGS


§173.25(a)(4)

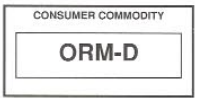
§172.312(a)


§172.322


§172.325


§172.302(g) and §173.9


§172.313(a)




§172.316(a)




§172.316(a)(1)

Keep a copy of the North American Emergency Response

# Hazardous Materials Warning Placards

CLASS 1


EXPLOSIVES
*Enter Division Number 1.1, 1.2, or 1.3 and compatibility group letter, when required. Placard any quantity.

CLASS 1


EXPLOSIVES 1.4
*Enter compatibility group letter, when required. Placard 454 kg (1,001 lbs) or more.

CLASS 1


EXPLOSIVES 1.5
*Enter compatibility group letter, when required. Placard 454 kg (1,001 lbs) or more.

CLASS 1


EXPLOSIVES 1.6
*Enter compatibility group letter, when required. Placard 454 kg (1,001 lbs) or more.

CLASS 2


OXYGEN
Placard 454 kg (1,001 lbs) or more gross weight of either compressed gas or refrigerated liquid.

CLASS 2


FLAMMABLE GAS
Placard 454 kg (1,001 lbs) or more.

CLASS 2


NON-FLAMMABLE GAS
Placard 454 kg (1,001 lbs) or more gross weight.

CLASS 2 Division 2.3


POISON GAS
Placard any quantity.

CLASS 3


FLAMMABLE
Placard 454 kg (1,001 lbs) or more.

CLASS 3


GASOLINE
May be used in the place of FLAMMABLE placard displayed on a cargo tank or a portable tank being used to transport gasoline by highway.

CLASS 3


COMBUSTIBLE
Placard a combustible liquid when transported in bulk. See §172.504(f)(2)for use of FLAMMABLE placard in place of COMBUSTIBLE placard.

CLASS 3


FUEL OIL
May be used in place of COMBUSTIBLE on a placard displayed on a cargo tank or portable tank being used to transport by highway fuel oil not classed as a flammable liquid.

CLASS 4


FLAMMABLE SOLID
Placard 454 kg (1,001 lbs) or more.

CLASS 4


SPONTANEOUSLY COMBUSTIBLE
Placard 454 kg (1,001 lbs) or more.

CLASS 4


DANGEROUS WHEN WET
Placard any quantity of Division 4.3 material.

CLASS 5


OXIDIZER
Placard 454 kg (1,001 lbs) or more.

CLASS 5


ORGANIC PEROXIDE
Placard any quantity, TYPE B, temperature controlled. Placard 454 kg (1,001 lbs) or more other than TYPE B, temperature controlled.

CLASS 6


POISON-INHALATION HAZARD
Placard any quantity of 6.1, Zone A or B inhalation hazard only.


POISON
Placard 454 kg (1,001 lbs) or more of PGI or II, other than Zone A or B inhalation hazard.


KEEP AWAY FROM FOOD
Placard 454 kg (1,001 lbs) or more of PG III.

CLASS 7


RADIOACTIVE
Placard any quantity - packages bearing RADIOACTIVE YELLOW-III labels only. Certain low specific activity radioactive materials in "exclusive use" will not bear the label, but the Radioactive placard is required for exclusive use shipments of low specific activity material and surface contaminated objects transported in accordance with §173.427 (b)(3) or (c).

CLASS 8


CORROSIVE
Placard 454 kg (1,001 lbs) or more.

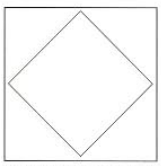
CLASS 9


MISCELLANEOUS
Not required for domestic transportation. A bulk packaging containing a Class 9 material must be marked with the appropriate ID number displayed on a Class 9 placard, an orange panel or a white square-on-point display.


DANGEROUS
A freight container, unit load device, transport vehicle, or rail car which contains non-bulk packagings with two or more categories of hazardous materials that require different placards specified in Table 2 may be placarded with DANGEROUS placards instead of the specific placards required for each of the materials in Table 2. However, when 1,000 kg (2,205 lbs) or more of one category of material is loaded at one loading facility, the placard specified in Table 2 must be applied.

SUBSIDIARY RISK PLACARD


Class numbers do not appear on a subsidiary risk placard.



White square background required for placard for highway route controlled quantity radioactive material and for rail shipment of certain explosives and poisons, and for flammable gas in a DOT 113 tank car (see §§172.507 and 172.510).

**UN or NA Identification Numbers**

PLACARDS OR ORANGE PANELS


and

Appropriate Placard must be used.


MUST BE DISPLAYED ON: (1) Tank Cars, Cargo Tanks, Portable Tanks, other Bulk Packaging, and (2) On vehicle or containers containing large quantities (8,820) lbs.) In non-bulk packages of only a single hazardous material, and certain quantities (2,205) of a material poisonous by inhalation in Hazard Zone A or B, having the same proper shipping name and Identification number.

**Guidebook handy! Response begins with identification!**

# General Guidelines on Use of Warning Labels and Placards

## LABELS

See 49 CFR, Part 172, Subpart E for complete labeling regulations.

- Until October 1, 1999, labels for materials poisonous by inhalation that conform to the requirements of the HMR in effect on September 30, 1997, may be used to satisfy the requirements of Subpart E.
- Those labels in boxes marked "TRANSITION-2001" on the chart are not authorized for use under Subpart E. (NOTE: these labels may be used IF they were affixed to a package offered for transportation and transported prior to October 1, 2001, and the package was filled with hazardous materials prior to October 1, 1991.)
- For classes 1,2,3,4,5,6 and 8, text indicating a hazard (e.g., "CORROSIVE") IS NOT required on a label. The label must otherwise conform to Subpart E [Section 172.405].
- Any person who offers a hazardous material for transportation MUST label the package, if required [Section 172.400(a)].
- The Hazardous Materials Table [Section 172.101] identifies the proper label(s) for the hazardous material listed.
- When required, labels must be printed on or affixed to the surface of the package near the proper shipping name [Section 172.406(a)].
- When two or more labels are required, they must be displayed next to each other [Section 172.406(c)].
- Labels may be affixed to packages when not required by regulations, provided each label represents a hazard of the material contained in the package [Section 172.401].

## PLACARDS

See 49 CFR, Part 172, Subpart F for complete placarding regulations.

- Until October 1, 2001, placards for materials poisonous by inhalation, by all modes of transportation, may be used that conform to specifications for placards (1) in effect on September 30, 1991, (2) specified in the December 21, 1990 final rule, (HM-181) or (3) specified in the July 22, 1997 final rule (HM-206).
- All of the placards appearing on the Hazardous Materials Warning Placards chart may be used to satisfy the placarding requirements contained in Subpart F.
- Each person who offers for transportation or transports any hazardous material subject to the Hazardous Materials Regulations shall comply with all applicable requirements of Subpart F.
- Placards may be displayed for a hazardous material even when not required, if the placarding otherwise conforms to the requirements of Subpart F.
- For other than Class 7 or the OXYGEN placard, text indicating a hazard (e.g., "CORROSIVE") is not required on a placard [Section 172.519(b)].
- Any transport vehicle, freight container, or rail car containing any quantity of material listed in Table 1 must be placarded [Section 172.504].
- When the gross weight of all hazardous materials in non-bulk pkgs. covered in Table 2 is less than 454 kg (1,001 lbs), no placard is required on a transport vehicle or freight container [Section 172.504].

Effective October 1, 1994, and extending through October 1, 2001, these placards may be used for HIGHWAY TRANSPORTATION ONLY.


Illustration numbers in each square refer to Tables 1 and 2 below.

## Inhalation Hazard Materials


§172.540


§172.555


§172.313

Materials which meet the inhalation toxicity criteria have additional "communication standards" prescribed by the HMR. First, the words "Poison-Inhalation Hazard" must be entered on the shipping paper, as required by Section 172.203(m)(3). Second, packagings must be marked "Inhalation Hazard" or, alternatively, when the words "Inhalation Hazard" appear on the label or placard, the "Inhalation Hazard" marking is not required on the package. Transport vehicles, freight containers, portable tanks and unit load devices that contain a poisonous material subject to the "Poison-Inhalation Hazard" shipping description, must be placarded with a POISON INHALATION HAZARD or POISON GAS placard, as appropriate. This shall be in addition to any other placard required for that material in Section 172.504.

**Table 1 (Placard any quantity)**

| Hazard class or division | Placard name |
|---|---|
| 1.1 | EXPLOSIVES 1.1 |
| 1.2 | EXPLOSIVES 1.2 |
| 1.3 | EXPLOSIVES 1.3 |
| 2.3 | POISON GAS |
| 4.3 | DANGEROUS WHEN WET |
| 5.2 (Organic peroxide, Type B, liquid or solid, temperature controlled) | ORGANIC PEROXIDE |
| 6.1 (Inhalation Hazard, Zone A or B) | POISON INHALATION HAZARD |
| 7 (Radioactive Yellow III label only) | RADIOACTIVE |

**Table 2 (Placard 1,001 pounds or more)**

| | |
|---|---|
| 1.4 | EXPLOSIVES 1.4 |
| 1.5 | EXPLOSIVES 1.5 |
| 1.6 | EXPLOSIVES 1.6 |
| 2.1 | FLAMMABLE GAS |
| 2.2 | NON-FLAMMABLE GAS |
| 3 | FLAMMABLE |
| Combustible Liquid | COMBUSTIBLE |
| 4.1 | FLAMMABLE SOLID |
| 4.2 | SPONTANEOUSLY COMBUSTIBLE |
| 5.1 | OXIDIZER |
| 5.2 (Other than organic peroxide, Type B, liquid or solid, temperature controlled) | ORGANIC PEROXIDE |
| 6.1 (PG I or II, other than Zone A or B inhalation hazard) | POISON |
| 6.1 (PG III) | KEEP AWAY FROM FOOD |
| 6.2 | NONE |
| 8 | CORROSIVE |
| 9 | CLASS 9 |
| ORM-D | NONE |

For complete details, refer to one or more of the following:

- Code of Federal Regulations, Title 49, Transportation, Parts 100-185. [All modes]
- International Civil Aviation Organization (ICAO) Technical Instructions for Safe Transport of Dangerous Goods by Air [Air]
- International Maritime Organization (IMO) Dangerous Goods Code [Water]
- Transportation of Dangerous Goods Regulations of Transport Canada. [All Modes]


U.S. Department of Transportation
**Research and Special Programs Administration**

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CHART 11
REV. JULY 1998

## Material Safety Data Sheets

The Material Safety Data Sheet (MSDS) has become a major source of chemical information. It is the key document used to provide hazard information to employees and can become an invaluable tool for emergency response personnel when used in a chemical emergency.

The Occupational Safety and Health Administration s (OSHA) Hazard Communication Standard (29 CFR 1910.1200) requires all manufacturers of pure chemicals and/or mixtures to evaluate their products and relate, via MSDSs, any hazards that may be encountered while handling these materials. This standard is intended for all workplaces, manufacturing and nonmanufacturing alike. The Environmental Protection Agency s (EPA) Emergency Response and Community Right-to-Know Act of 1986 ensures the availability of MSDSs to emergency response personnel, such as fire departments, first aid crews, and hospital emergency room staff.

The MSDS contains a wealth of information that may be understood with a minimum of training. Below is a brief explanation of the format and information found in a properly prepared MSDS.

### Section 1

This section identifies the material by product or trade name and chemical name. It is the product or trade name that is usually found on the container labels, although the chemical name is also required by some states. Section I also contains the manufacturer s name, address, and telephone number.

### Section 2

Section 2 provides physical data about the product that can be utilized for proper identification. Included are specifics such as color, odor, specific gravity (weight), vapor pressure, and boiling point.

### Section 3

This section lists the chemical ingredients of the material, if they are known or suspected to be hazardous. Hazardous materials that are not carcinogens must be reported if they represent 1 percent or more of the product. Carcinogens must be reported and identified as such if their levels are 0.1 percent or higher. Also included in Section 3 are Threshold Limit Values (TLVs) and the OSHA Permissible Exposure Limit (PEL).

### Section 4

Section 4 includes fire and explosion hazard data. This information is especially useful when devising both in-house and community contingency plans. Plant first responders, local fire departments, and hazmat teams need unlimited access to this information.

### Section 5

Section 5 contains health hazard data. It describes any acute (short-term exposure) and/or chronic (long-term exposure) effects on the body. These include routes of exposure (inhalation, dermal contact, ingestion) and the bodily organs affected, as well as the signs and symptoms of overexposure. First

aid procedures are also be found in this section. (NOTE: First aid measures recommended in MSDSs are not always correct and should be confirmed.)

## Section 6

This section contains information on the reactivity of the product. It lists other chemicals that, when mixed with the product, will result in a chemical reaction. If a product is water reactive, it will be noted.

Also included in Section 6 is information on hazardous decomposition products, such as carbon monoxide and other hazardous gases, that are formed and emitted during chemical reactions or fires. It is imperative that this section be carefully noted by both in-house and local firefighters.

## Section 7

Section 7 lists the procedures that should be used if the product spills or leaks, including waste disposal methods.

## Section 8

Section 8 contains information regarding the proper personal protective equipment (PPE) necessary to handle the product in a manner that will minimize exposure. Ventilation practices are also listed in this section.

## Summary

A Material Safety Data Sheet can aid in making the right decisions on health and safety issues in a plant or in a community. It must be noted, however, that it is but one of many references that should be used to make final determinations. MSDSs are offered by manufacturers for identification and verification and are not the last word on safety and health practices.

# 1. MATERIAL SAFETY DATA SHEET

| | |
|---|---|
| PRODUCT NAME: | CAS # |
| CHEMICAL NATURE: | |
| % ACTIVITY: | |

## 2. PHYSICAL DATA

| | | | |
|---|---|---|---|
| BOILING POINT, 760 MM HG | | FREEZE POINT | |
| SPECIFIC GRAVITY | | VAPOR PRESSURE AT 20 C | |
| VAPOR DENSITY | | SOLUBILITY IN H20 | |
| PER CENT VOLATILES BY WEIGHT | | IONIC NATURE | |
| APPEARANCE AND ODOR | | | |

## 3. CHEMICAL INGREDIENTS

| MATERIAL | % | TLV (Units) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

## 4. FIRE AND EXPLOSION HAZARD DATA

| | | | | | |
|---|---|---|---|---|---|
| FLASH POINT (test methods) | | AUTOIGNITION TEMPERATURE | | | |
| FLAMMABLE LIMITS IN AIR, % by volume | | Lower | | Upper | |
| EXTINGUISHING MEDIA | | | | | |
| SPECIAL FIRE FIGHTING PROCEDURES | | | | | |
| UNUSUAL FIRE AND EXPLOSION HAZARDS | | | | | |

*SAMPLE MATERIAL SAFETY DATA SHEET*

## 5. HEALTH HAZARD DATA

| |
|---|
| TRESHOLD LIMIT VALUE |
| EFFECTS OF EXPOSURE |
| EMERGENCY AND FIRST AID PROCEDURES |

## 6. REACTIVE DATA

| | | | |
|---|---|---|---|
| STABILITY | | CONDITIONS TO AVOID | |
| UNSTABLE | STABLE | | |
| | | | |
| COMPATIBILITY | | | |
| HAZARDOUS RECOMPOSITION PRODUCTS | | | |
| HAZARDOUS POLYMERIZATION | | CONDITIONS TO AVOID | |

## 7. SPILL OR LEAK PROCEDURES

| | |
|---|---|
| STEPS TO BE TAKEN OR MATERIAL IS RELEASED OR SPILLED | |
| WASTE DISPOSAL METHOD | |

## 8. SPECIAL PROTECTION INFORMATION

| | | | | |
|---|---|---|---|---|
| RESPIRATORY PROTECTION | | | | |
| VENTILATION | LOCAL EXHAUST | | SPECIAL | |
| | MECHANICAL | | OTHER | |
| PROTECTIVE GLOVES | | | EYE PROTECTION | |
| OTHER PROTECTIVE EQUIPMENT | | | | |

## 9. SPECIAL PRECAUTIONS

| | |
|---|---|
| PRECAUTIONARY LABELING | |
| OTHER HANDLING AND STORAGE CONDITIONS | |

*SAMPLE MATERIAL SAFETY DATA SHEET*

# Appendix B

## Types of Respiratory Protection

## Appendix B
## Types of Respiratory Protection

| Type of Respirator | Advantages | Disadvantages |
|---|---|---|
| **Air Purifying** | | |
| *Air-Purifying Respirator* (including powered sea level) [PAPRs]) | Enhanced mobility | Cannot be used in IDLH or oxygen-deficient atmospheres (less than 19.5 percent oxygen at air-purifying respirators |
| | Lighter in weight than an SCBA; generally weighs 2 pounds or less (except for PAPRs) | Limited duration of protection; may be hard to gauge safe operating time in field conditions |
| | | Only protects against specific chemicals, and up to specific concentrations |
| | | Use requires monitoring of contaminant and oxygen levels |
| | | Can only be used: (1) against gas and vapor contaminants with adequate warning properties; or (2) for specific gases or vapors provided that the service is known and a safety factor is applied, or if the unit has an ESLI (end-of-service-life-indicator) |
| **Atmosphere-Supplying** | | |
| *Self-Contained Breathing Apparatus (SCBA)* | Provides the highest available level of protection against airborne contaminants and oxygen deficiency | Bulky, heavy (up to 35 pounds) |
| | | Finite air supply limits work duration |
| | Provides the highest available level of protection under strenuous work conditions | May impair movement in confined spaces |

## Appendix B (continued)

| Type of Respirator | Advantages | Disadvantages |
|---|---|---|
| *Positive Pressure Supplied-Air Respirator (SAR)* | Enables longer work periods than an SCBA | Not approved for use in IDLH or oxygen-deficient atmospheres (less 19.5 percent oxygen at sea level) unless equipped with an emergency egress unit, such as an escape-only SCBA, that can provide immediate emergency respiratory protection in case of air line failure |
| (also called air line respirator) | Less bulky and heavy than an SCBA; SAR equipment weigh less than 5 pounds (or around 15 pounds, if escape SCBA protection is included) | Impairs mobility |
| | Protects against most airborne contaminants | Mine Safety and Health Administration/ NIOSH certification limits hose length to 300 feet |
| | | As the length of the hose is increased, the minimum approved airflow may not be delivered at the faceplate |
| | | Air line is vulnerable to damage, chemical contamination, and degradation. Decontamination of hoses may be difficult |
| | | Worker must retrace steps to leave work area |
| | | Requires supervision/monitoring of the air supply line |

# Appendix C

## Levels of Protection

## Appendix C
## Levels of Protection[1]

| Level of Protection | Equipment | Protection Provided | Should be used when: | Limiting Criteria |
|---|---|---|---|---|
| **A** | **Recommended:**<br>Pressure-demand, full facepiece SCBA or pressure-demand, supplied-air respirator with escape SCBA<br><br>Fully-encapsulated, chemical-resistant suit<br><br>Inner chemical-resistant gloves<br><br>Chemical-resistant safety boots/shoes<br><br>Two-way radio communication | The highest available level of respiratory, skin, and eye protection | The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory systems based on:<br><br>-measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or<br><br>-site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin | Fully-encapsulated suit; material must be compatible with the substances involved |
| | **Optional:**<br>Cooling unit<br><br>Coveralls<br><br>Long cotton underwear<br><br>Hard hat<br><br>Disposable gloves and boot covers | | Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible<br><br>Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined | |

[1] Reprinted from NIOSH/OSHA/USCG/EPA, 1985. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.* Washington, DC: Department of Health and Human Services.

## Appendix C
## Levels of Protection (continued)

| Level of Protection | Equipment | Protection Provided | Should be used when: | Limiting Criteria |
|---|---|---|---|---|
| **B** | **Recommended:**<br>Pressure-demand, full-facepiece SCBA or pressure-demand, supplied-air respirator with escape SCBA<br><br>Chemical-resistant clothing (overalls and long sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit)<br><br>Inner and outer chemical-resistant gloves<br><br>Chemical-resistant safety boots/shoes<br><br>Hard hat<br><br>Two-way radio communications<br><br>**Optional:**<br>Coveralls<br><br>Disposable boot covers<br><br>Face shield<br><br>Long cotton underwear | The same level of respiratory protection, but less skin protection than Level A<br><br>It is the minimum level recommended for initial site entries until the hazards have been further identified | The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves:<br><br>-atmosphere with IDLH concentrations of specific substances that do not represent a severe skin hazard; or<br><br>-atmosphere containing less than 19.5 percent oxygen<br><br>Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through intact skin | Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through intact skin<br><br>Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin |

## Appendix C
## Levels of Protection (continued)

| Level of Protection | Equipment | Protection Provided | Should be used when: | Limiting Criteria |
|---|---|---|---|---|
| **C** | **Recommended:**<br>Full-facepiece, air-purifying, canister-equipped respirator<br><br>Chemical-resistant clothing (overalls and long sleeved jacket: hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit)<br><br>Hard hat<br><br>**Optional:**<br>Gloves<br><br>Escape mask<br><br>Face shield | No respiratory protection; minimal skin protection | The atmosphere contains no known hazard<br><br>Work functions preclude, splashes immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals | This level should not be worn in the Exclusion Zone<br><br>The atmosphere must contain at least 19.5 percent oxygen |
| **D** | **Recommended:**<br>Coveralls<br><br>Safety boots/shoes<br><br>Safety glasses or chemical splash goggles<br><br>Hard hat<br><br>**Optional:**<br>Gloves<br><br>Escape mask<br><br>Face Shield | No respiratory protection; minimal skin protection | The atmosphere contains no known hazard<br><br>Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals | This level should not be worn in the Exclusion Zone<br><br>The atmosphere must contain at least 19.5 percent oxygen |

## Comments

The Agency for Toxic Substances and Disease Registry would greatly appreciate your comments and suggestions for improving future editions of this guidance document. Comments may be addressed to:

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# *Managing Hazardous Materials Incidents*

## Volume II
***(revised)***

## Hospital Emergency Departments

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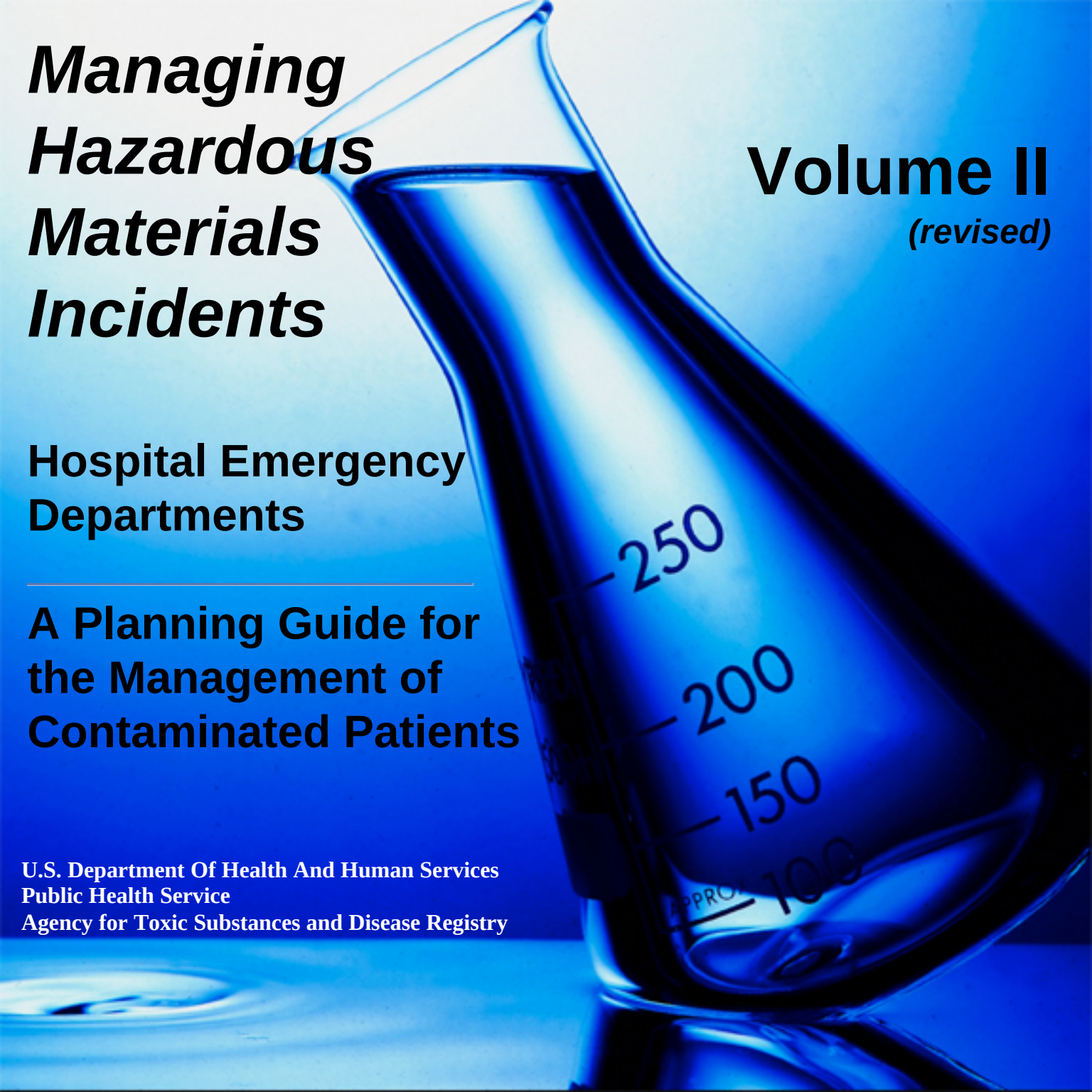
## A Planning Guide for the Management of Contaminated Patients




**U.S. Department Of Health And Human Services**
**Public Health Service**
**Agency for Toxic Substances and Disease Registry**

# *Managing Hazardous Materials Incidents*

***Volume II***
***(Revised)***

## Hospital Emergency Departments:

## A Planning Guide for the Management of Contaminated Patients

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**
Public Health Service
Agency for Toxic Substances and Disease Registry

The Agency for Toxic Substances and Disease Registry (ATSDR) has produced a three-volume series entitled Managing Hazardous Material Incidents. The series is designed to help emergency response and health care professionals plan for and respond to hazardous material emergencies.

| | |
|---|---|
| Volume I | Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients |
| Volume II | Hospital Emergency Departments: A Planning Guide for the Management of Contaminated Patients |
| Volume III | Medical Management Guidelines for Acute Chemical Exposures |

Volumes I and II are planning guides to assist first responders and hospital emergency department personnel in planning for incidents that involve hazardous materials.

Volume III is a guide for health care professionals who treat persons who have been exposed to hazardous materials.

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# Volume II - Table of Contents

## Volume II - Table of Contents (Continued)

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2000 Revision of *Volume I*
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*A Planning Guide for the Management*
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John Turley (Emergency Management Institute)

[1] The above reviewers were recommended by the organizations listed but do not necessarily represent them.

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# Introduction

The presence of hazardous materials or toxic chemicals at an incident location or other emergency situation adds a new dimension of risk to those handling and treating casualties. The fundamental difference between a hazardous materials incident and other emergencies is the potential for acute risk from contamination to both patient and responder. In some cases, traditional practices must be altered to avoid compounding a critical situation.

Hospital emergency departments must protect their personnel and other people within the hospital, while providing the best care for the chemically contaminated patient. This guide is intended to help hospital emergency departments plan for incidents that involve hazardous materials and to improve their ability to respond to these incidents.

To ensure appropriate and timely patient care, as well as optimal worker protection, emergency personnel must understand decontamination procedures and personal protective equipment, neither of which are routinely covered in the course of their professional training. They should also be aware of community resources that could be called upon to assist with an emergency response.

Current training curricula for emergency room physicians and nurses and emergency medical technicians (EMTs) often do not adequately prepare these professionals to manage the contaminated individual or to decontaminate patients exposed to toxic substances. Accurate, specific, and concise guidance is needed to describe appropriate procedures to be followed by emergency medical personnel to safely care for a patient, as well as to protect equipment, hospital personnel, patients, and others from risk of secondary exposure. In response to this need, the Agency for Toxic Substances and Disease Registry (ATSDR) contracted for the production of a three-volume series entitled *Managing Hazardous Materials Incidents:* I. Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients; II. Hospital Emergency Departments: A Planning Guide for the Management of Contaminated Patients; and III. Medical Management Guidelines for Acute Chemical Exposures. The first document is designed for use by emergency medical technicians and other prehospital care providers to minimize their risks of exposure during the prehospital period and to provide for the safe and effective treatment of chemically contaminated patients.

This volume, written for emergency department personnel, is designed to familiarize readers with the concepts, terminology, and key operational considerations that affect the management of incidents of chemical contamination. It presents uniform guidance for the emergency care of chemically contaminated patients; provides basic information critical to advance planning and implementation of emergency medical strategies; illustrates the characteristics of hazardous materials incidents that compel modifications to traditional emergency response procedures; and presents effective preparatory response actions.

Not all hospital and community emergency response systems are prepared to respond to a hazardous chemical incident to the same degree. This document may be used to assess a hospital s capabilities with respect to potential community hazards and to develop response plans using national and community-specific resources. Employee safety and training are also key factors in the effective management of medical emergencies. This document also is intended to provide source material for developing local training and safety protocols.

Section I, *Systems Approach to Planning,* introduces the guidelines for emergency preparedness and hazardous materials and waste programs of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). Government and private planning activities are also outlined, including those established under Title III of the Superfund Amendments and Reauthorization Act (SARA); the National Response Team; the Community Awareness Emergency Response (CAER) program; and the Chemical Stockpile Emergency Preparedness Program (CSEPP). This chapter discusses the need for hazard identification and risk analysis pertaining to hazardous materials located in a community or transported through it.

Section II, *Emergency Department Response to Hazardous Materials Incidents,* outlines general principles for hazard recognition, chemical exposure, and personal protective equipment. In addition, the hazard recognition section presents general guidance for determining whether a given situation constitutes a hazardous materials incident and details various hazardous materials classification systems. This section also provides basic toxicological and chemical terminology that emergency personnel need to understand to effectively conduct patient assessments. It also provides an overview of personal protective equipment, such as respiratory devices and protective clothing.

Section III, *Patient Management,* includes guidelines for emergency department preparation and response to a potential hazardous materials incident. This chapter also discusses patient assessment and decontamination guidelines.

This guidance document is intended to improve the safety of responders as well as of patients. It is not, however, all-encompassing, nor can it be regarded as a substitute for comprehensive instruction and training for hazardous materials incidents. Supplemental material that is vital to successful response to hazardous materials contamination is cited within the document. These materials should be carefully reviewed before preparing any strategic plans or conducting training exercises on this topic. Also, this document generally does not cover issues associated with weapons of mass destruction (WMD), although some of the information presented is pertinent to these situations as well. Other ATSDR documents specifically address WMD concerns.

# Section I. Systems Approach To Planning

## The Role of the Hospital in a Systems Approach to Planning

The potential for hazardous materials incidents exists almost everywhere. While infrequent, chemical incidents are capable of endangering the health of the individuals involved and the emergency personnel directed to assist them. People who have been seriously injured by a hazardous material have a greater chance of recovery without complications when appropriate emergency treatment is provided by trained EMS personnel at the scene, and when the patient is transported to a facility having the most appropriate personnel and technical resources to manage his or her care. This requires an integrated emergency medical response. However, many local governments, private businesses, and hospitals do not have a tested hazardous materials response plan in place that integrates all of the responding agencies and personnel. This has resulted in several problems:

- Incidents have been poorly managed onsite by first responders.
- Communication channels between the private and public sectors, or among public responders, have not been clearly identified and formalized.
- The medical community has not been firmly integrated into many response systems and may not be prepared to treat multiple casualties resulting from a serious hazardous materials incident.

Hospitals are a crucial link in the community response system for emergency preparedness planning. Not only are hospitals asked to treat patients who have been chemically contaminated at remote sites, but as repositories of hazardous materials themselves, they are potential sites of hazardous materials incidents. Coordination and communication between hospitals and other elements of an Emergency Medical Services system can best be achieved by hospital staff, including physicians, fully participating at local meetings for hazardous materials (hazmat) planning and protocol review.

Hospitals must acknowledge their role as a component of the communitywide emergency response system. Hospital administrators need to familiarize themselves with the contingency plans of other participants, such as fire, police, Emergency Medical Services (EMS), and health departments, and understand what services are expected from hospitals. Optimally, hospital staff should be represented on planning committees that develop and periodically review these contingency plans.

A common characteristic of the successful management of chemical incidents is adequate contingency planning. Local emergency planning committees are mandated under federal law to identify high-risk locations and to ensure adequate response planning and training. Planning requires the involvement of an array of community institutions, including fire and police departments, and community hospitals. Not every hospital in an area needs to have an emergency department capable of handling hazardous materials patients. In fact, many communities have centralized such services into one major area hospital or trauma center. However, all hospitals should be capable of performing decontamination and basic care since some patients may come in on their own and not through EMS systems. In addition, emergency department personnel must be knowledgeable about where to send patients for further specialized care.

## The Spectrum of Hazardous Materials Incidents

EMS agencies and hospitals should be able to participate in the response to a range of hazmat incidents from the individual level, through the multi-casualty, to the mass-casualty level. The hospital and emergency medical responders are key components of the local response system. Planning should integrate hospital personnel, equipment, and supply needs into state and local hazmat plans. In turn, the hospital must be familiar with these plans and know how to use them if it is involved in a incident that overwhelms its capabilities.

- **Individual patient:** A single individual is contaminated and must be transported to an emergency department:
  - Can occur in the workplace, in a public place, or at home.
  - May pose a problem in rural areas with small hospitals, or where there are low levels of hazmat skills and experience among EMTs.
- **Multi-casualty:** This situation is usually limited to a single location:
  - Involves normal systems of transportation.
  - Patients are usually treated at the same level facility as a single emergency response, but the demand on all systems is much greater.
- **Mass-casualty:** Disrupts a large segment of the community:
  - Involves several locations.
  - Involves additional units to the normal responders (mutual aid); such units may not be part of the local EMS system, and these units may not know how the system works.
  - Involves long-range mutual aid; normal systems of transportation (ambulances) are inadequate or disrupted.
  - Patients may be treated locally at different facilities that provide various levels of care, or even outside of the area altogether.

While transportation incidents attract larger media attention, statistics show that almost 75 percent of all acute hazardous materials events, excluding fuel spills, occur in the fixed locations where the materials are used or stored. In addition, events resulting in death and injury occur almost 1.5 times as often in fixed locations as in transit.

Hazardous materials incidents range from small releases at a factory site to rapidly expanding events that may endanger a community. Regardless of the size or location of an incident, its successful management depends on preplanning. This preplanning often requires coordination between local, state, and federal agencies, and industries, as well as those in the community who use and maintain stocks of potentially hazardous materials. Contributions to hazardous materials planning come from a variety of sources: regulations from the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), state and local planning committees established under Title III of the Superfund Amendments and Reauthorization Act (SARA), state EMS agencies, and federal agencies.

## Joint Commission on Accreditation of Healthcare Organizations (JCAHO)

In drawing up contingency plans, hospital administrators have guidance available from the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). The JCAHO establishes standards that must be met before a hospital can receive accreditation. A comprehensive accreditation survey takes place once every three years, with intermittent evaluation(s) if a specific area of weakness is identified at the time of full review.

While the JCAHO has in the past provided very specific guidelines relating to emergency department resources, handling of hazardous materials, and emergency preparedness, current JCAHO guidance takes the form of standards to be met. These standards allow hospitals more leeway in how specific goals are achieved.

## SARA Title III

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) provides for an infrastructure in states and local communities to plan for effective response to hazardous materials emergencies. The legislation also provides for public access to information on the presence and releases of specified hazardous chemicals in communities.

Title III, The Emergency Planning and Community Right-to-Know Act of 1986, requires that each state establish a State Emergency Response Commission (SERC), consisting of members with technical expertise in emergency response, environmental and natural resources, public health, occupational safety, media, and transportation. The SERC is responsible for establishing local emergency planning districts (usually on a county level), appointing and overseeing local emergency planning committees (LEPCs), establishing procedures for handling public requests for information, and reviewing LEPC emergency plans.

SARA Title III requires that the local committees include, at a minimum, representatives from the following groups: state and local officials, law enforcement, civil defense, firefighters, environmental, *hospital,* media, *first aid, health,* transportation, and facility owners or operators subject to the emergency planning requirements. LEPCs were primarily responsible for preparing a comprehensive emergency response plan for their districts by October 1988, using information about the presence of potentially hazardous chemicals reported by businesses and other facilities under Title III. LEPCs were also charged with making information on hazardous chemicals available to the public.

As part of the planning process, each LEPC must evaluate available resources for developing, implementing, and exercising its plan. The plan must include:

- Identification of facilities subject to planning provisions under Title III
- Identification of transportation routes for extremely hazardous substances
- Identification of risk-related facilities
- Methods and procedures for response

- Designated community and facility coordinators
- Procedures for public notification
- Methods for determining release occurrence and the area affected
- Description of emergency equipment and facilities and those responsible for them
- Evacuation plans and training programs

Under Title III s planning provisions, EPA was mandated by Congress to establish a list of chemicals to help focus local emergency planning activities. In April 1987, EPA listed 406 Extremely Hazardous Substances (EHSs) and established a Threshold Planning Quantity (TPQ) for each. Any business or facility that contains one or more of these EHSs in an amount equal to or greater than its respective TPQ is required to notify the SERC and LEPC. These facilities must also appoint a coordinator to work with the LEPC for specific inclusion of that facility in the local plan.

Representative facilities covered under the planning provisions include not only major chemical manufacturing facilities but a wide variety of chemical users, such as farmers, dry cleaners, and other service-related businesses. Exemptions under this provision apply only to vessels (ship/boat), federal facilities, and transportation operations. Storage incidental to transportation is exempt provided that the EHSs are still moving under active shipping papers and have not reached the final consignee.

Accidental releases of EHSs and other hazardous materials identified in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) must be reported to the LEPC and SERC. This requirement ensures immediate notification of local response personnel. Other provisions of Title III provide additional information on the presence, storage, and emissions of hazardous and toxic chemicals. These data further assist the LEPC in obtaining a comprehensive picture of chemical risk in the local district.

Hospitals can be better prepared to respond to incidents that involve contaminated patients by actively participating in the LEPC planning process. Title III provides for the submission of information on hazardous and toxic chemicals as presented above. In addition, Title III contains a specific provision requiring facility owners or operators to disclose the chemical identity of substances for which companies have made trade secret claims. Access to chemical identities assists health professionals, physicians, and nurses in obtaining further information for diagnostic and treatment recommendations during emergencies, and for prevention and treatment measures during nonemergencies.

## The State Emergency Medical Services (EMS) Agency

Planning for hazardous materials incidents should include the appropriate linkage to the state EMS agency. These state agencies are responsible for overseeing a network of local EMS units, and thus are an essential part of the planning process. This body is often part of the SERC.

The duties of these agencies vary from state to state. However, EMS agencies usually are responsible for medical management and medical control of injured civilians and first responders. EMS agencies must develop medical mutual aid agreements between counties and establish procedures for distribution

of casualties among hospitals. In addition, EMS agencies should maintain an inventory of disaster medical supplies. EMS agencies should also develop and maintain communications protocols for onsite activities (e.g., between receiving hospitals and the base hospital, between base hospitals and ambulances, between all hospitals and the regional Poison Control Center). Further, EMS agencies must work with local and state officials in designating field casualty decontamination and collection points for a major disaster, and in arranging for the acquisition of additional equipment, supplies and pharmaceuticals.

State planning activities include:

- **Medical Direction:** The local EMS agency or base hospital should be contacted for information on how medical control is provided for the EMS system.

- **Patient Destination:** Hospital emergency departments are able to provide supportive care. In some cases, however, it may be more appropriate to take the patient to a hospital that has expertise in handling certain kinds of poison exposures. The plan should include directions for obtaining this information. One option is to go through the regional Poison Control Center or through the base hospital. The Poison Center will often know which hospitals are best prepared to handle exposures to which substances.

- **Decontamination and Medical Management Protocols:** The literature on the clinical management of hazardous materials exposures is sometimes inconsistent in its recommendations. Provisions should be made in the plan for obtaining field and hospital medical management information from experienced physicians. For example, the regional Poison Control Center can provide decontamination and medical management protocols via fax or telephone to all receiving hospitals, and through the base hospital or via cellular telephone to EMTs in the field. The Poison Center also has rapid access to experts, including its own medical director, who is a medical toxicologist with training and experience in hazardous materials. Volume III in this series, *Medical Management Guidelines for Acute Chemical Exposures,* provides extensive information on many commonly encountered chemicals.

- **Coordination with Burn Centers, Trauma Centers, Hyperbaric Chamber Facilities, and Other Specialty Centers:** Provisions should be made to alert and coordinate patient destination with various specialty care centers.

## Federal Emergency Response Activities

Contingency planning is essential to the successful implementation of any system designed to manage chemically contaminated patients and to promptly contain the hazard itself. Contingency plans require a coordinated community response that may also involve state and federal agencies. Preplanning and coordination of services are equally critical at the national level. The federal government established a National Contingency Plan (NCP) to promote coordination of the resources and services of federal and state response systems. To oversee this plan, a National Response Team (NRT) and a National Response Center, a network of Regional Response Teams (RRTs), and a group of On-Scene Coordinators (OSCs) have been established.

The *Hazardous Materials Emergency Planning Guide,* referred to as NRT-1, provides guidance to help local communities prepare for potential hazardous materials incidents. NRT-1 can be used by local communities developing their own plans, as well as by LEPCs formed in accordance with the Emergency Planning and Community Right-to-Know Act of 1986 (SARA Title III).

The objectives of the *Hazardous Materials Emergency Planning Guide* are to:

- Focus communities on emergency preparedness and response.
- Provide communities with information that can be used to organize the emergency planning task.
- Furnish criteria for risk and hazard assessments, and to assist communities in determining whether a hazardous materials incident plan is needed, in addition to the districtwide plan developed by the LEPC.
- Help LEPCs and individual communities prepare a plan that is appropriate for their needs and consistent with their capabilities.
- Provide a method for revising, testing, and maintaining community emergency plans.

NRT-1 is published by the National Response Team, and was developed cooperatively by its federal member agencies, including the Department of Defense, Department of the Interior, Department of Transportation, U.S. Coast Guard, Environmental Protection Agency (EPA), Department of Commerce (National Oceanic and Atmospheric Administration [NOAA]), Federal Emergency Management Agency (FEMA), Department of State, Department of Agriculture, Department of Health and Human Services (Agency for Toxic Substances and Disease Registry [ATSDR]), Department of Justice, General Services Administration (GSA), Department of the Treasury, Department of Labor (Occupational Safety and Health Administration [OSHA]), Nuclear Regulatory Commission (NRC), and the Department of Energy (DOE). NRT-1 represents a concerted effort by federal agencies to consolidate their general hazardous materials planning guidance into an integrated federal document.

NRT-1 states that an emergency plan must include response procedures for facilities and local emergency and medical personnel, as well as a description of emergency equipment and facilities in the community. It also recommends that hospital, emergency medical service, and health department personnel be included as members of an emergency planning team. As previously mentioned, SARA Title III requires medical, hospital, and first aid personnel to be members of the local emergency planning committee. NRT-1 describes relevant publications that provide specific operational guidance to emergency responders, such as the DOT s *North American Emergency Response Guidebook (NAERG),* which provides guidance for firefighters, police, and other emergency services personnel to help them protect themselves and the public during the initial minutes immediately following a hazardous materials incident.

In addition, the document provides information on the Chemical Manufacturers Association s (CMA) Community Awareness Emergency Response (CAER) and Chemical Transportation Emergency Center (CHEMTREC) programs. The CAER program encourages local chemical manufacturing facilities to inform area residents, public officials, and emergency response organizations about industry operations and to integrate their onsite emergency response plans with the planning efforts

of the local community. In some areas of the country, the chemical industry has established physician networks to encourage better dialogue between company physicians and local health authorities. CAER has outlined specific steps for industrial plants:

- Review the plant s emergency plan
- Improve employee awareness and training
- Prepare a community relations plan
- Inventory the status of local emergency planning
- Develop a briefing paper
- Prepare a list of initial contacts
- Meet with initial contacts and identify key officials
- Establish a coordinating group
- Begin implementation steps

On the federal level, EPA and FEMA provide technical assistance and guidance to local and state planners through the SARA Title III program.

The NRT-1 document also recommends that contingency plans include standard operating procedures for entering and leaving sites, accountability for personnel entering and leaving sites, decontamination procedures, recommended safety and health equipment, and personal safety precautions. The document suggests that emergency plans include a list of emergency response equipment appropriate to the various degrees of hazard based on EPA s four levels of protection (Levels A through D; see Section II). Further, it recommends that the list include the type of respirator (i.e., self-contained breathing apparatus, supplied-air respirator, or air-purifying respirator) that should be used, the type of clothing that must be worn, and the equipment needed to protect the head, eyes, face, ears, hands, arms, and feet.

In addition, NRT-1 recommends that medical personnel be made aware of significant chemical hazards in the community to prepare for possible hazardous materials incidents. It also states that emergency medical teams and hospital personnel must be trained in the proper methods for decontaminating and treating individuals exposed to hazardous chemicals.

## Hazard Analysis

Hazard analysis is a necessary component of comprehensive emergency planning for a community. It is a three-step decisionmaking process comprised of hazard identification, vulnerability analysis, and risk analysis. This section focuses primarily on hazard identification.

The first task in conducting such an analysis is to complete an inventory of the hazardous materials present in the community and to determine the nature of the hazard. This is a key step because it permits planners to describe and evaluate risks and to allocate resources accordingly. However, the

task of analyzing all relevant hazards may not prove cost effective for many communities. The planning committee should, therefore, assign priorities to the hazards found in its community and establish affordable limits for analysis. It should be noted that several federal agencies (e.g., DOT, FEMA, EPA) report that frequently encountered substances often pose the most prevalent dangers. These materials include fuels and chemicals, such as chlorine, ammonia, and hydrochloric and sulfuric acids. Such materials should be given special attention by the LEPC in the planning process.

In this context, a hazard is any situation that is capable of causing injury or impairing an individual s health. During the process of identifying hazards, facilities or transportation routes will be pinpointed that contain materials that are potentially dangerous to humans. The identification of hazards also should provide information on: (1) the types, quantities, and locations of hazardous materials in the community, or transported through a community; and (2) the nature of the hazard that would accompany incidents, such as explosions, spills, fires, and venting to the atmosphere.

Hazards should be identified at as many facilities in the community as possible. These include the obvious ones such as chemical plants, refineries, petroleum plants, storage facilities, and warehouses. In requesting information directly from facilities, remember that the planning provisions under SARA Title III require certain facilities to provide the LEPC with any information on the facility that the committee needs to develop and implement its plan. The LEPCs may provide assistance here, particularly if the committee includes industry representatives. It is essential that these industries or businesses understand the role this information plays in ensuring a sound emergency response plan. As previously stated, placing business or industrial representatives on the communitywide planning committee, as required under SARA Title III, should facilitate their cooperation. The assistance and cooperation of a facility that regularly deals with hazardous materials also presents the local planning unit with a wide array of services. For example, such a facility can provide technical experts, Spill Prevention Control and Countermeasure (SPCC) plans, training and safe handling instructions, and cleanup capabilities.

In identifying hazards, hospitals and educational and governmental facilities should not be overlooked since they all contain a variety of chemicals. Major transportation routes and transfer points, such as airports, vessels in port, railroad yards, and trucking terminals, should also be included in the overall hazards identification plan. SARA Title III planning provisions address many of these potential transportation risk areas by requiring facility cooperation in plan preparation and by including specific risk areas as well as a wide range of chemical handlers, from manufacturers to service-related businesses.

Risk analysis includes the probable damage that may occur if a chemical incident occurs. Information that is necessary for risk analysis includes:

- The type of risk to humans, such as an acute, chronic, or delayed reaction
- The groups that are most at risk
- The type of risk to the environment, such as permanent damage or a recoverable condition

Many documents can be of assistance in conducting a risk analysis. Risk analysis in transportation settings is outlined in the DOT s *Community Teamwork: Working Together To Promote Hazardous Materials Safety, A Guide for Local Officials.* In conjunction with FEMA and DOT, EPA published a supplement to NRT-1 in December 1987. This document, entitled *Technical Guidance for Hazardous Analysis* and often referred to as the Green Book, provides technical assistance to LEPCs in assessing the lethal hazards associated with potential airborne releases of extremely hazardous substances.

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# Section II. Emergency Department Response to Hazardous Materials Incidents

## Hazard Recognition

When dispatched to the scene of an incident, emergency response personnel may not be aware that the situation involves hazardous materials. As a result, emergency department personnel should always be alert to the possibility that they may be dealing with a chemically contaminated individual, and they should ask incident victims and prehospital personnel about the nature of the event. Emergency departments should also be prepared for exposed patients who arrive unannounced in privately-owned vehicles. Patients may also originate from situations occurring within the hospital. An injury at a hazardous materials incident need not invariably involve chemical exposure: it could have resulted from a physical accident, such as slipping off a ladder. But as a routine precaution, the involvement of hazardous materials should be considered a possibility in such situations. The manual *Recognizing and Identifying Hazardous Materials* (produced by the National Fire Academy and the National Emergency Training Center) states that there are six primary clues that may signify the presence of hazardous materials. These clues are included below to facilitate and expedite the prompt and correct identification of any hazardous materials at the scene of an incident. Hospital emergency department personnel who are familiar with these clues will find their communication with field personnel enhanced. For example, patient symptoms reported from the field such as nausea, dizziness, itching and burning eyes or skin, or cyanosis could suggest to hospital staff the presence of hazardous materials. They could then request field personnel to examine the site for these six clues:

- **Occupancy and Location.** Community preplanning should identify the specific sites that contain hazardous materials. In addition, emergency personnel should be alert to the obvious locations in their communities that use and/or store hazardous materials (e.g., laboratories, factories, farm and paint supply outlets, construction sites). The Department of Labor s Material Safety Data Sheets (MSDSs) should also be available, especially for any particularly dangerous chemicals kept on site. It should be kept in mind, however, that these data sheets may have incomplete information and that the medical information provided is generally at a basic first aid level.

- **Container Shape.** Department of Transportation (DOT) regulations delineate container specifications for the transport of hazardous materials. There are three categories of packaging: stationary bulk storage containers at fixed facilities that come in a variety of sizes and shapes; bulk transport vehicles, such as rail and truck tank cars, that vary in shape depending upon the cargo; and labeled fiberboard boxes, drums, or cylinders for smaller quantities of hazardous materials. The shape and configuration of the container can often be a useful clue to the presence of hazardous materials.

- **Markings/Colors.** Certain transportation vehicles must use DOT markings, including identification (ID) numbers. Identification numbers, located on both ends and both sides, are required on all cargo tanks, portable tanks, rail tank cars, and other packages that carry hazardous materials. Railcars may have the names of certain substances stenciled on the side of the car. A marking scheme designed by the National Fire Protection Association (NFPA 704M System) identifies hazard characteristics of materials at terminals and industrial sites, but does not provide product-specific information. This system uses a diamond divided into four quadrants. Each quadrant represents a different characteristic: the left, blue section refers to health; the top, red quarter pertains to flammability; the right, yellow area is for reactivity; and the bottom, white quadrant highlights special information (e.g., W indicates dangerous when wet, Oxy stands for oxidizer). A number from zero through four in each quadrant indicates the relative risk of the hazard, with zero representing the minimum risk. This system does not indicate what the product is, the quantity, or its exact location. In addition, it does not reveal the compound s reactivity with other chemicals. The military also uses distinctly shaped markings and signs to designate certain hazards. These markings may be found on vehicles, on the products themselves, or on shipping papers.

- **Placards/Labels.** These convey information through use of colors, symbols, Hazard Communication Standards, American National Standard Institute (ANSI) Standards for Precautionary Labeling of Hazardous Industrial Chemicals, United Nations Hazard Class Numbers, and either hazard class wording or four-digit identification numbers. Placards are used when hazardous materials are being stored in bulk (usually over 1,001 lb), such as in cargo tanks. Labels designate hazardous materials kept in smaller packages. Caution must be exercised, however, because the container or vehicle holding a hazardous material may be improperly labeled or recorded, or it may not have any exterior warning.

- **Shipping Papers.** Shipping papers can clarify what is labeled as dangerous on placards. They should provide the shipping name, hazard class, ID number, and quantity, and may indicate whether the material is waste or poison. Shipping papers, which must accompany all hazardous material shipments, are now required to list a 24-hour emergency information telephone number. The location where the shipping papers are stored can be problematical; often they are found in close proximity to the hazardous material(s) or in other locations not easily accessible during an emergency. Shipping papers should remain at the incident scene for use by all response personnel.

- **Senses.** Odor, vapor clouds, dead animals or fish, fire, and skin or eye irritation can signal the presence of hazardous materials. Generally, if one detects an odor of hazardous materials, it should be assumed that exposure has occurred and the individual is still in the danger area, although some chemicals have a detectable odor at levels below their toxic concentrations. Some chemicals, however, can impair an individual s sense of smell (e.g., hydrogen sulfide), and others have no odor, color or taste at all (e.g., carbon monoxide). Binoculars are helpful to ascertain visible information from a safe distance.

Appendix A provides greater detail on the NFPA s 704M system; the DOT s hazardous materials marking, labeling, and placarding guide; and the Department of Labor s MSDS. It is important that any and all available clues are used in substance identification, especially obvious sources such as the information provided on a label or in shipping papers.

The aim of the health provider should be to make a chemical-specific identification while exercising caution to prevent exposure to any chemicals. Identifying the hazardous material and obtaining information on its physical characteristics and toxicity are vital steps to the effective management of a hazardous materials incident. Since each compound has its own unique set of physical and toxicological properties, early and accurate identification of the hazardous material(s) involved allows emergency personnel to initiate appropriate management steps.

Many resources are available to provide information concerning response to and planning for hazardous materials incidents. All such information, however, needs to be interpreted with respect to the specific release scenario. A selected bibliography of written material is included at the end of each section of this guidebook; it is not, however, a complete list of the materials available. Printed reference materials provide several advantages: they are readily available, they can be kept in the response vehicle, they are not dependent on a power source or subject to malfunction, and they are relatively inexpensive. Disadvantages include the difficulty of determining the correct identity for an unknown chemical through descriptive text, the logistics of keeping the materials current, and the problem that no single volume is capable of providing all the information that may be needed.

There is also a vast array of telephone and computer-based information sources concerning hazardous materials. They can help by describing the toxic effects of a chemical, its relative potency, and the potential for secondary contamination. They may also recommend decontamination procedures, clinical management strategies, and advice on the adequacy of specific types of protective gear. Exhibit II-1A is a partial listing of the many information resources available by telephone. Exhibit II-1B is a list of suggested telephone numbers that should be filled in for your community, including the regional Poison Control Center, which is a ready source of information 24 hours a day. Exhibit II-2 provides a partial listing of computerized and online information sources. Note, however, that not all online databases are peer reviewed; for example, some medical management information may be based only on DOT or MSDS data. Care and planning should be used when selecting information sources. Planning is an essential part of every response, and many of these resources can provide guidance in the formation of an effective response plan.

## Exhibit II-1A
## Telephone Information and Technical Support References

| Resource | Contact | Services Provided |
|---|---|---|
| Chemical Transportation Emergency Center (CHEMTREC) | 1-800-424-9300 | 24-hour emergency number connecting with manufacturers and/or shippers. Advice provided on handling, rescue gear, decontamination considerations, etc. Also provides access to the Chlorine Emergency Response Plan (CHLOREP). |
| Agency for Toxic Substances and Disease Registry (ATSDR) | 1-404-639-6360 | 24-hour emergency number for health-related support in hazardous materials emergencies, including onsite assistance. |
| Bureau of Explosives | 1-719-585-1881 | Contact number for technical questions about railway transport of hazardous materials. For emergencies, call CHEMTREC (1-800-424-9300). |
| Emergency Planning and Community Right-to-Know Act (EPCRA) and Resource Conservation and Recovery Act (RCRA) Information Hotline | 1-800-424-9346 | Available 9:00 a.m. to 6:00 p.m. (EST). Provides information on SARA Title III, list of extremely hazardous substances, and planning guidelines. |
| Environmental Protection Agency (EPA) Regional Offices | website: www.epa.gov/regional | Environmental response teams available for technical assistance. |
| Region I (CT, ME, MA, NH, RI, VT) | 1-617-918-1111 | |
| Region II (NJ, NY, PR, VI) | 1-212-637-3000 | |
| Region III (DE, DC, MD, PA, VA, WV) | 1-215-814-2900; intra-regional only: 1-800-438-2474 | |
| Region IV (AL, FL, GA, KY, MS, NC, SC, TN) | 1-404-562-9900; Emergency Response & Removal Branch: 1-800-564-7577 | |
| Region V (IL, IN, MI, MN, OH, WI) | 1-312-353-2000 | |
| Region VI (AR, LA, NM, OK, TX) | 1-214-665-2200 | |
| Region VII (IA, KS, MO, NE) | 1-913-551-7003 | |
| Region VIII (CO, MT, ND, SD, UT, WY) | 1-303-312-6312 | |
| Region IX (AZ, CA, HI, NV; Pacific Islands AS, FM, GU, MH, MP, PW) | 1-415-744-1500; emergencies: 1-415-744-2000 | |
| Region X (AK, ID, OR, WA) | 1-206-553-1200 | |

## Exhibit II-1A (continued)

| Resource | Contact | Services Provided |
|---|---|---|
| National Animal Poison Control Center | 1-800-548-2423<br>1-888-426-4435 | 24-hour consultation services concerning animal poisonings or chemical contami - nation. Provides an emergency response team to investigate incidents and to perform laboratory analysis. |
| National Pesticides Information Retrieval System (NPIRS) | 1-765-494-6616<br>website:<br>ceris.purdue.edu/npirs | Contact information for help in searching NPIRS database to get fact sheets on pesticides, insecticides, fungicides, and state and federally registered chemicals. |
| National Pesticide Telecommunications (NPTN)<br>(Oregon State University) | 1-800-858-7378<br><br>website:<br>ace.orst.edu/info/nptn | Provides information about pesticide-Network related topics, including pesticide products, recognition and management of pesticide poisoning, toxicology, environmental chemistry, referrals for laboratory analyses, investigation of pesticide incidents, emergency treatment, safety, health and environmental effects, cleanup, and disposal procedures. |
| National Response Center | 1-800-424-8802 | A federal hotline for reporting oil and chemical spills where hazardous materials are responsible for death, serious injury, property damage in excess of $50,000, or continuing danger to life and property. |
| U.S. Army Soldier and Biological Chemical Command (SBCCOM) | 1-800-368-6498 | 24-hour consultation service for threats and releases pertaining to chemical and biological agents. |

## Exhibit II-1B
## Local Telephone Information and Technical Support Resource Worksheet

| Resource | Contact (fill in for future reference) | Services Provided (fill in for future reference) |
|---|---|---|
| EPA Regional or State Office | | |
| Regional Poison Control Center | | |
| State Emergency Response Commission | | |
| State Health Department | | |
| State Emergency Management Office | | |
| Local Fire Department | | |
| Local Hazardous Materials | | |
| Response Team | | |
| Community Police Department | | |
| Local Emergency Planning Committee | | |
| Local Health Department | | |
| State Department of Natural Resources | | |
| FEMA Regional Office | | |
| State Agriculture Office | | |
| State Lab Office | | |
| State EMS Office | | |
| Hyperbaric Medicine Chamber | | |
| Burn Center | | |
| CDC | | |
| U.S. Army Soldier and Biological Chemical Command | | |

## Exhibit II-2
## Computerized Data Sources for Information and Technical Support

| Data System | Contact | Description |
|---|---|---|
| CAMEO | CAMEO Database Manager<br>7600 Sand Point Way, N.E.<br>Seattle, Washington 98115<br>(206) 526-6317<br>website: www.epa.gov/ceppo/cameo | Computer-aided management of National Oceanic and Atmospheric Administration (NOAA) operations available to on-scene responder(s). Chemical identification database assists in Hazardous Materials Response Division determining substance(s) involved, predicting downwind concentrations, providing response recommendations, and identifying potential hazards. |
| CHRIS | CIS, Inc.<br>c/o Oxford Molecular Group<br>11350 McCormick Road<br>Executive Plaza, Suite 1100<br>Hunt Valley, Maryland 21031<br>(800) 247-8737<br>website: www.oxmol.com/software/cis/details/CHRIS.shtml | Chemical Hazard Response Information System, developed by the Coast Guard and comprised of reviews on fire hazards, fire-fighting recommendations, reactivities, physicochemical properties, health hazards, use of protective clothing, and shipping information for over 1,000 chemicals. |
| HAZARDTEXT | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111-4740<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | Assists responders dealing with incidents involving hazardous materials, such as spills, leaks, and fires. Provides information on emergency medical treatment and recommendations for initial hazardous response. |
| HMIS | Kevin Coburn<br>Information Systems Manager<br>U.S. Department of Transportation<br>D.H.M. 63 - Room 8104<br>400 7th Street SW<br>Washington, D.C. 20590-0001<br>website: www.dlis.dla.mil/hmis.htm | Hazardous Material Information Systems contains information on hazardous materials. Transportation-related incidents may be reported on DOT form 5800.1 (Hazardous Materials Incident Report Form). |
| HSDB | HSDB Representative<br>National Library of Medicine<br>Specialized Information Systems<br>8600 Rockville Pike<br>Bethesda, Maryland 20894<br>(301) 496-6531<br>website: sis.nlm.nih.gov/sis1 | Hazardous Substances Data Bank, compiled by the National Library of Medicine, provides reviews on the toxicity, hazards, and and regulatory status of over 4,000 frequently used chemicals. |

## Exhibit II-2 (continued)

| Data System | Contact | Description |
|---|---|---|
| 1st MEDICAL RESPONSE PROTOCOLS | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | Helps develop training programs and establish protocols for first aid or initial workplace response to a medical emergency. |
| MEDITEXT | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | Provides recommendations regarding the evaluation and treatment of exposure to industrial chemicals. |
| OHMTADS | Oxford Molecular Group, Inc.<br>11350 McCormick Rd.<br>Executive Plaza 3, Suite 1100<br>Hunt Valley, Maryland 21031<br>(800) 247-8737<br>website: www.oxmol.com/software/cis/details/OHMTADS.shtml | Oil and Hazardous Materials/Technical Assistance Data Systems provides information on the effects of spilled chemical compounds and their hazardous characteristics and properties, assists in identifying unknown substances, and recommends procedures for handling cleanups. |
| TOMES | Micromedex, Inc.<br>Suite 300<br>6200 S. Syracuse Way<br>Englewood, Colorado 80111<br>(800) 525-9083<br>website: www.micromedex.com/products/pd-main.htm | The Tomes Plus Information Systems is a series of comprehensive databases on a single CD-ROM disc. It provides information regarding hazardous properties of chemicals and medical effects from exposure. The Tomes Plus database contains Meditext, Hazardtext, HSBD, CHRIS, OHMTADS, and 1st Medical Response Protocols. |
| TOXNET | Toxicology Data Network (TOXNET)<br>National Library of Medicine<br>Specialized Information Services<br>8600 Rockville Pike<br>Bethesda, Maryland 20894<br>(301) 496-6531<br>website: sis.nlm.nih.gov/sis1 | A computerized system of three toxicologically oriented data banks operated by the National Library of Medicine the Hazardous Substances Data Bank, the Registry of Toxic Effects of Chemical Substances, and the Chemical Carcinogenesis Research Information System. TOXNET provides information on the health effects of exposure to industrial and environmental substances. |

## Principles of Toxicology for Emergency Department Personnel

Exposure to hazardous chemicals may produce a wide range of adverse health effects. The likelihood of an adverse health effect occurring, and the severity of the effect, are dependent on: (1) the toxicity of the chemical; (2) the route of exposure; (3) the nature and extent of exposure; and (4) factors that affect the susceptibility of the exposed person, such as age and the presence of certain chronic diseases. To better understand potential health effects, emergency department personnel should understand the basic principles and terminology of toxicology.

Toxicology is the study of the nature, effects, and detection of poisons in living organisms. Examples of these adverse effects, sometimes called toxic end points, include carcinogenicity (development of cancer), hepatotoxicity (liver damage), neurotoxicity (nervous system damage), and nephrotoxicity (kidney damage). This is merely a sample list of toxic end points that might be encountered (Exhibit II-3).

Toxic chemicals often produce injuries at the site which they come into contact with the body. A chemical injury at the site of contact, typically the skin and the mucous membranes of the eyes, nose, mouth, or respiratory tract, is termed a *local toxic effect*. Irritant gases such as chlorine and ammonia can, for example, produce a localized toxic effect in the respiratory tract, while corrosive acids and bases can result in local damage to the skin. In addition, a toxic chemical may be absorbed into the bloodstream and distributed to other parts of the body, producing *systemic effects*. Many

**Exhibit II-3**
**Examples of Adverse Health Effects from Exposure to Toxic Chemicals**

| Toxic End Point | Target Organ Systems | Example of Causative Agent | Health Effect Acute | Health Effect Chronic |
|---|---|---|---|---|
| Carcinogenicity | Multiple sites | Benzene | Dermatitis | Acute myelogenous leukemia |
| | | | Chest tightness | |
| | | | Dizziness | |
| | | | Headache | |
| Hepatotoxicity | Liver | Carbon tetrachloride | Vomiting | Liver necrosis |
| | | | Abdominal pain | Fatty liver |
| | | | Dizziness | |
| | | | Rash | |
| Neurotoxicity | Nervous system | Lead | Nausea | Wrist drop |
| | | | Vomiting | IQ deficits |
| | | | Abdominal pain | Encephalopathy |
| Nephrotoxicity | Kidney | Cadmium | Vomiting | Kidney damage |
| | | | Diarrhea | Anemia |
| | | | Chest pain | |

pesticides, for example, are absorbed through the skin, distributed to other sites in the body, and produce adverse effects such as seizures or cardiac, pulmonary, or other problems. It is important for medical providers to recognize that exposure to chemical compounds can result not only in the development of a single systemic effect but also in the development of multiple systemic effects or a combination of systemic and local effects. Some of these effects may be delayed, sometimes for as long as 48 or more hours. Health effects can also be acute or chronic. Acute health effects are short-term effects that manifest within hours or days, such as vomiting or diarrhea. Chronic health effects are long-term effects that may take years to manifest, such as cancer.

## Routes and Extent of Exposure

There are three main routes of chemical exposure: inhalation, dermal contact (with skin or mucous membranes), and ingestion. *Inhalation* results in the introduction of toxic compounds into the respiratory system, and potentially into the bloodstream. Most of the compounds that are commonly inhaled are gases or vapors of volatile liquids. However, solids and liquids can be inhaled as dusts or aerosols. Inhalation of toxic agents generally results in a rapid and effective absorption of the compound into the bloodstream because of the large surface area of the lung tissue and number of blood vessels in the lungs. Knowing a chemical s vapor pressure (VP) can be useful in determining the inhalation risk for a particular exposure. The lower the VP, the less likely the chemical will produce an inhalable gas and vice versa. Water solubility is also an important contributor for symptom development. Irritant agents that are water soluble usually cause early upper respiratory tract irritation, resulting in coughing and throat irritation. Partially water-soluble chemicals penetrate into the lower respiratory system causing delayed symptoms (12 to 24 h) which include trouble breathing, pulmonary edema, and coughing up blood. Asphyxiants are chemicals that impede the body s ability to obtain or utilize oxygen. Simple asphyxiants are inert gases (e.g., argon, propane, nitrogen) that displace oxygen in inspired air. Chemical asphyxiants produce harm by preventing oxygen delivery or utilization for energy production by the body s cells. Carbon monoxide and cyanide are examples of asphyxiants.

*Dermal contact* does not typically result in as rapid absorption as inhalation, although some chemicals are readily taken in through the skin. Many organic compounds are lipid (fat) soluble and can therefore be rapidly absorbed through dermal exposure. Some materials that come in contact with the eyes can also be absorbed.

*Ingestion* is a less common route of exposure for emergency response personnel at hazardous materials incidents. However, incidental hand-to-mouth contact, smoking, and swallowing of saliva and mucus that contains contaminants may also result in exposure by this route. In addition, emergency medical personnel in both hospital or prehospital settings treat chemical exposures in patients who have ingested toxic substances as a result of accidental poisonings or suicide attempts.

Compounds may also be introduced into the body through *injection,* although this is an unlikely route of exposure in spills or discharges of hazardous materials. Explosions may result in injection injuries and lead to imbedded foreign bodies, which may themselves be chemically contaminated.

The route by which personnel are exposed to a compound plays a role in determining the total amount of the substance taken up by the body because a compound may be absorbed by one route more readily than by another. In addition, the route of exposure may affect the nature of the symptoms that develop. The amount of the compound absorbed by the body also depends on the duration of exposure and the concentration of the compound to which one is exposed.

It is important to recognize that children may be more susceptible to many toxic exposures, in part because they are likely to receive a higher dose relative to body weight than an adult. This occurs for a number of reasons. First, children are shorter than adults and since most toxic gases are heavier than air, the concentrations increase as you get closer to the ground. Children s immature central nervous system, liver, and renal system also increase their susceptibility to injury as a result of exposure to chemicals. In addition, children have a larger lung surface area relative to their weight than adults, as well as a greater respiratory volume (liters/min/kg of body weight). It is probable that the child s lung is a more effective absorbent surface than that of the adult. Children also have a larger skin area relative to their weight than do adults, allowing more effective surface area for absorption in dermal exposures. A child s skin is also more easily penetrated by chemicals, allowing for more rapid and effective dermal absorption. Finally, children are more likely to ingest toxic chemicals because of increased hand-to-mouth behavior, including pica. All of these factors may lead to an increased dose relative to size in children as compared to adults, even when they all are exposed to the same scenario.

A complex relationship exists between the total amount of the compound absorbed by the body (dose) and the concentration of that compound in the environment. This relationship is important for emergency medical personnel to understand because the adverse effects produced by a toxic compound are usually related to the dose of that compound received by a patient. However, because we usually only monitor the concentration of the toxic substance in the environment (e.g., parts per million (ppm) of a compound in air), the actual dose of the compound received by the patient is seldom known. Factors specific to the exposed patient, such as area of skin surface exposed, presence of open wounds or breaks in the skin, and the rate and depth of respirations, are important in estimating the dose of the compound received by the patient.

## Dose-Response Relationship

The effect produced by a toxic compound is primarily a function of the dose of the compound. This principle, termed the dose-response relationship, is a key concept in toxicology. Many factors affect the normal dose-response relationship and they should be considered when attempting to extrapolate toxicity data to a specific situation (Exhibit II-4).

Typically, as the dose increases, the severity of the toxic response increases. Humans exposed to 100 ppm of tetrachloroethylene, a solvent that is commonly used for dry-cleaning fabrics, may experience relatively mild symptoms, such as headache and drowsiness. However, exposure to 200 ppm tetrachloroethylene can result in a loss of motor coordination in some individuals, and exposure to 1,500 ppm for 30 minutes may result in a loss of consciousness (Exhibit II-5). As shown in Exhibit II-5, the severity of the toxic effect also depends on the duration of exposure, a factor that influences the dose of the compound in the body.

## Exhibit II-4
## Classification of Factors Influencing Toxicity

| Type | Examples |
|---|---|
| Factors related to the chemical | Composition (salt, freebase, etc.); physical characteristics (size, liquid, solid, etc.); physical properties (volatility, solubility, etc.); presence of impurities; breakdown products; carriers |
| Factors related to exposure | Dose; concentration; route of exposure (inhalation, ingestion, dermal); duration |
| Factors related to the exposed person | Heredity; immunology; nutrition; hormones; age; sex; health status; preexisting diseases; pregnancy |
| Factors related to environment | Media (air, water, soil, etc.); additional chemicals present; temperature; humidity; air pressure; and fire |

## Exhibit II-5
## Dose-Response Relationship for Humans Inhaling Tetrachloroethylene Vapors

| Levels in Air | Duration of Exposure | Effects on Nervous System |
|---|---|---|
| 50 ppm | | Odor threshold |
| 100 ppm | 7 hours | Headache, drowsiness |
| 200 ppm | 2 hours | Dizziness, uncoordination |
| 600 ppm | 10 minutes | Dizziness, loss of inhibitions |
| 1,000 ppm | 1-2 minutes | Marked dizziness, intolerable eye and respiratory tract irritation |
| 1,500 ppm | 30 minutes | Coma |

Toxicity information is often expressed as the dose of a compound that causes an effect in a percentage of the exposed subjects, which are usually experimental animals. These dose-response terms are often found in the Material Safety Data Sheets (MSDSs) and other sources of health information. One dose-response term that is commonly used is the lethal dose 50 ($LD_{50}$). This is the dose that is lethal to 50 percent of an animal population from exposure by a specific route (except inhalation) when given all in one dose. A similar term is the lethal concentration 50 ($LC_{50}$), which is the concentration of a material in air that on the basis of respiratory exposure in laboratory tests is expected to kill 50 percent of a group of test animals when administered as a single exposure (usually 1 hour). Exhibit II-6 lists a number of chemicals that may be encountered in dealing with hazardous materials incidents, and the reported acute $LD_{50}$ values of these compounds when they are administered by ingestion to rats.

From Exhibit II-6 it can be seen that a dose of 3,000 to 3,800 mg/kg tetrachloroethylene is lethal to 50 percent of rats that received the compound orally; however, only 6.4 to 10 mg/kg of sodium cyanide is required to produce the same effect. Therefore, compounds with low $LD_{50}$ values are more acutely toxic than substances with higher $LD_{50}$ values.

The $LD_{50}$ values that appear in an MSDS or in the literature must be used with caution by emergency medical personnel. These values are an index of only one type of response and give no indication of the ability of the compound to cause nonlethal, adverse or chronic effects. They also do not reflect possible additive effects from the mixture of chemicals sometimes found with exposure to hazardous materials. Furthermore, $LD_{50}$ values typically come from experimental animal studies. Because of the anatomical and physiological differences between animals and humans, it is difficult to compare the effects seen in experimental animal studies to the effects expected in humans exposed to hazardous materials in the field. $LC_{50}$ and $LD_{50}$ values are also usually determined in healthy adult animals. Values determined in young animals may be quite different, as may values determined in animals with an underlying disease. It is known that many chemicals are more toxic (lower $LD_{50}$ or $LC_{50}$ values) in young or newborn animals than in adults. This same age dependence may exist in humans. Because several organs, particularly the brain, are still developing in young children, damage to these organs may be more extensive and can be permanent. Also, infants may not be able to excrete chemicals from the body as efficiently as adults because their kidneys and liver are not fully developed. This may lead to longer and greater exposure to the chemical than would occur in an adult with the same relative exposure. The immaturity of metabolizing enzymes in the liver may lead to either increased or decreased toxicity in infants relative to adults. Which may occur is difficult to predict for many chemicals. Therefore, emergency medical personnel should remember that the $LD_{50}$ and $LC_{50}$ values are only useful for comparing the relative approximate toxicity of compounds.

**Exhibit II-6**
**Acute $LD_{50}$ Values for Representative Chemicals When Administered Orally to Rats**

| Chemical | Acute Oral $LD_{50}$ (mg/kg)[1] |
|---|---|
| Sodium cyanide | 6.4-10 |
| Pentachlorophenol | 50-230 |
| Chlordane | 83-560 |
| Lindane | 88-91 |
| Toluene | 2,600-7,000 |
| Tetrachloroethylene | 3,000-3,800 |

[1] Milligrams of the compound administered per kilogram body weight of the experimental animal.

Responses to toxic chemicals may differ among individuals because of the physiological variability that is present in the human population. Some individuals, for example, are more likely to experience adverse health effects after exposure to a toxic chemical because of a reduced ability to metabolize that compound. The presence of preexisting medical conditions (e.g., pulmonary, hepatic, or renal disease, diabetes) can also increase one s susceptibility to toxic chemicals. Respiratory distress in people with asthma may be triggered by exposure to toxic chemicals at lower concentrations than might be expected to produce the same effect in individuals without respiratory disease. Factors such as age, personal habits (e.g., smoking, diet), previous exposure to toxic chemicals, and medications may also increase an individual s sensitivity to toxic chemicals. Therefore, exposure to concentrations of toxic compounds that would not be expected to result in the development of a toxic response in most people may cause an effect in susceptible individuals. Not all chemicals, however, have a threshold level. Some carcinogens (cancer-causing chemicals) may produce a response (tumors) at any dose level, and any exposure to these compounds may be associated with some risk of developing cancer. Thus, literature values for levels that are not likely to produce an effect do not guarantee that an effect will not occur.

## Exposure Limits

The various occupational exposure limits found in the literature or on an MSDS are based primarily on time-weighted average limits, ceiling values, or ceiling concentration limits to which the worker can be exposed without adverse effects. Examples of these limits are listed in Exhibit II-7A.

The values listed in Exhibit II-7A were established to provide worker protection in occupational settings. Because the settings in which these values are appropriate are quite different than an uncontrolled spill site, it is difficult to interpret how these values should be used by emergency medical personnel when dealing with a hazardous materials incident. These values are designed for a healthy adult working population and have limited utility when applied to some of the at risk groups mentioned previously. At best, TLV, PEL, IDLH, and REL values can be used as benchmarks for determining relative toxicity, and perhaps to assist in selecting appropriate levels of personal protective equipment (PPE). Furthermore, these occupational exposure limits are only useful if trained personnel and appropriate instrumentation are available for measuring the levels of toxic chemicals in the air at the spill site. Of the occupational exposure limit values shown in Exhibit II-7A, only the OSHA values are regulatory limits. The ACGIH values are for guidance only and are not regulatory limits. In addition, the ACGIH limits have certain caveats that may or may not affect the usefulness of the values. Some of these conditions are individual susceptibility or aggravation of a preexisting condition. Because of the limitations of PELs and TLVs, special exposure limits have been established. Emergency Response Planning Guidelines (ERPGs), Short-term Public Emergency Guidance Levels (SPEGLs), and Acute Exposure Guidelines (AEGLs, under development by the EPA) have been designed to assist emergency personnel in making decisions regarding nonworkplace exposures (Exhibit II-7B). Emergency medical personnel responsible for the management of chemically contaminated patients should be familiar with all of these exposure limits because they will be encountered in various documents dealing with patient care or the selection of PPE.

This brief discussion highlights some fundamental concepts of toxicology. Emergency medical personnel responsible for managing chemically contaminated patients are encouraged to obtain further training in their recognition and treatment. A list of general toxicology references is provided at the end of this section that will allow emergency medical personnel to undertake a more in-depth examination of the principles of toxicology.

## Personnel Protection and Safety Principles

This section provides information on personal protective equipment (PPE) and safety principles to emergency medical personnel who, because of their proximity to a chemical industrial area or transport corridor, may be required to treat chemically contaminated patients. In the majority of cases, hospital staff will not experience incidents involving chemically contaminated patients frequently enough to keep them optimally trained or their equipment properly maintained. Staff must be initially trained in the proficient use of PPE, specifically respiratory equipment, and must maintain that proficiency. According to state and federal regulations, equipment must be maintained according to OSHA specifications, and respirators and their cartridges have to be properly fitted, tested, and stored. Many hospitals, given their workload mix and fiscal constraints, may not be able to expend the funds and time necessary to accomplish this task. In these cases, these hospitals should make arrangements with the local fire department or hazmat team to be ready, if the situation warrants, to decontaminate patients, including those who are transported to a hospital before they are decontaminated. Considerations in determining what a hospital s capabilities should be include the number of incidents occurring locally (several per week versus only a few per year) and proximity to industries or transportation routes that have the potential for a hazardous materials incident (see Section I SARA Title III).

## Exhibit II-7A
## Occupational Exposure Limits

| Value | Abbreviation | Definition |
|---|---|---|
| Threshold Limit Value (ACGIH)[1] | TLV | Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. |
| Threshold Limit Value: Time-Weighted Average (ACGIH)[1] | TLV-TWA | The time-weighted average concentration for a normal 8-hour work day and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. |
| Threshold Limit Value: Short-Term Exposure Limit (ACGIH)[1] | TLV-STEL | The concentration to which workers can be exposed continuously for a short period of time without suffering from (1) irritation, (2) chronic or irreversible tissue damage, or (3) narcosis of a sufficient degree to increase the likelihood of accidental injury, to impair self-rescue, or to materially reduce work efficiency; and provided that the daily TLV-TWA is not exceeded. |
| Threshold Limit Value: Ceiling (ACGIH)[1] | TLV-C | The concentration that should not be exceeded during any part of the working exposure. |
| Permissible Exposure Limit (OSHA)[2] | PEL | Same as TLV-TWA. |
| Immediately Dangerous to Life and Health (OSHA)[2] | IDLH | A maximum airborne concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects. |
| Recommended Exposure Limit (NIOSH)[3] | REL | Highest allowable airborne concentration that is not expected to injure a worker; expressed as a ceiling limit or time-weighted average for an 8- or 10-hour work day. |

[1] American Conference of Governmental Industrial Hygienists

[2] Occupational Safety and Health Administration

[3] National Institute for Occupational Safety and Health

## Exhibit II-7B
## General Population Exposure Limits

| Value | Abbreviation | Definition |
|---|---|---|
| Emergency Response Planning Guidelines (AIHA)[1] | ERPG | Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without (1) experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor (ERPG-1), (2) experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual s ability to take protective action (ERPG-2), or (3) experiencing or developing life-threatening health effects (ERPG-3). |
| Short-term Public Emergency Guidance Level (NRC)[2] | SPEGL | An acceptable concentration for unpredicted, single, short-term exposure of the general public in emergency situations. May be developed for different exposure periods (e.g., 1, 2, 4, 8, 16, 24 hours). |
| Acute Exposure Guidelines (EPA NAC/AEGL)[3] | AEGL | Proposed short-term threshold or ceiling exposure value intended for the protection of the general public, including susceptible or sensitive individuals but not those who are hypersusceptible or hypersensitive. Represents the airborne concentration of a substance at or above which it is predicted that the general population (as defined above) could experience (1) notable discomfort (AEGL-1), (2) irreversible or other serious, long-lasting effects or impaired ability to escape (AEGL-2), or (3) life-threatening effects or death (AEGL-3). Developed for four exposure periods: 30 minutes, and 1, 4 , and 8 hours. Synonymous with the NAS[4] term, Community Emergency Exposure Levels (CEELs). |

[1] American Industrial Hygiene Association

[2] National Research Council

[3] EPA National Advisory Committee/AEGL Committee

[4] National Academy of Sciences

## Federal Regulations Pertaining to Use of Personal Protective Equipment (PPE)

The term personal protective equipment (PPE) is used in this document to refer to both clothing and equipment. The purpose of PPE is to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered at a hazardous materials incident.

**Training is essential before any individual attempts to use PPE.** OSHA standards mandate specific training requirements (8 hours of initial training or sufficient experience to demonstrate competency) for personnel engaged in emergency response to hazardous substances incidents at the First Responder Operations Level. In addition, each employer must develop health and safety programs and provide for emergency response. These standards also are intended to provide additional protection for those who respond to hazardous materials incidents, such as firefighters, police officers, and EMS personnel. OSHA s final rule (March 6, 1989, 29 CFR (1910.120)) as it applies to emergency medical personnel states:  Training shall be based on the duties and functions to be performed by each responder of an emergency response organization.

No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus, PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. Responders in PPE can also be frightening to pediatric patients. In general, the greater the level of PPE protection, the greater are the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Excessive protection can be as hazardous as under-protection, and should be avoided. In addition, personnel should not be expected to use PPE without adequate training.

The two basic objectives of any PPE program should be to protect the wearer from safety and health hazards and to prevent injury to the wearer from incorrect use and/or malfunction of the PPE. To accomplish these goals, a comprehensive PPE program should include: (1) hazard identification; (2) medical monitoring; (3) environmental surveillance; (4) selection, use, maintenance, and decontamination of PPE; and (5) training.

## PPE Complications

Personnel wearing PPE are likely to encounter a number of potential problems, including limited visibility, reduced dexterity, claustrophobia, restricted movement, suit breach, insufficient air supply, dehydration, and the effects of heat and cold. Only individuals who are physically fit and have met the OSHA/NIOSH/NFPA training requirements should be wearing PPE during an incident. Proper donning and doffing procedures must be followed, with assistance from other onsite personnel. Medical surveillance evaluations should be conducted on all individuals both before and immediately after their use of PPE. The actions of all personnel wearing PPE should also be closely observed by the safety officer and others during each work period. In addition, an emergency distress signal should be identified in the briefing before individuals enter the work area.

## Levels of Protection

EPA has designated four levels of protection to assist in determining which combinations of respiratory protection and protective clothing should be employed:

**Level A** protection should be worn when the highest level of respiratory, skin, eye, and mucous membrane protection is needed. It consists of a fully-encapsulated, vapor-tight, chemical-resistant suit, chemical-resistant boots with steel toe and shank, chemical-resistant inner/outer gloves, coveralls, hard hat, and self-contained breathing apparatus (SCBA).

**Level B** protection should be selected when the highest level of respiratory protection is needed but a lesser degree of skin and eye protection is required. It differs from Level A only in that it provides splash protection through use of chemical-resistant clothing (overalls and long-sleeved jacket, two-piece chemical splash suit, disposable chemical-resistant coveralls, or fully-encapsulated, non-vapor-tight suit and SCBA).

**Level C** protection should be selected when the type of airborne substances is known, concentration is measured, criteria for using air-purifying respirators are met, and skin and eye exposures are unlikely. This involves a full facepiece, air-purifying, canister-equipped respirator and chemical-resistant clothing. It provides the same level of skin protection as Level B, but a lower level of respiratory protection.

**Level D** is primarily a work uniform. It provides no respiratory protection and minimal skin protection, and it should not be worn on any site where respiratory or skin hazards exist.

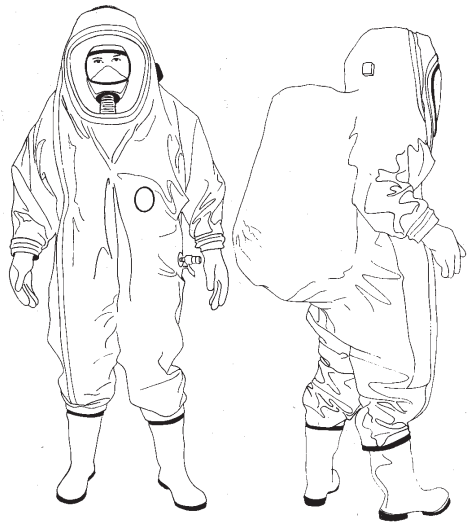
Exhibit II-8 illustrates these four levels of protection. For more information on this subject, Appendix C outlines the protective equipment recommended for each level of protection.

Factors to be considered in selecting the proper level of protection include the potential routes of entry for the chemical(s), the degree of contact, and the specific task assigned to the user. Activities can also be undertaken to determine which level of protection should be chosen. The EPA and NIOSH recommend that initial entry into unknown environments or into a confined space that has not been chemically characterized be conducted wearing at least Level B, if not Level A, protection.

## Routes of Entry

PPE is designed to provide emergency medical personnel with protection from hazardous materials that can affect the body by one of three primary routes of entry: inhalation, ingestion, and direct contact. *Inhalation* occurs when emergency personnel breathe in chemical fumes or vapors. Respirators are designed to protect the wearer from contamination by inhalation but they must be worn properly and fit-tested frequently to ensure continued protection. *Ingestion* usually is the result of a health care provider transferring hazardous materials from his hand or clothing to his mouth. This can occur unwittingly when an individual wipes his mouth with his hand or sleeve, eats, drinks, or smokes a cigarette. *Direct contact* refers to chemical contact with the skin or eye. Skin is protected by garments, and full-face respirators protect against ingestion and direct eye contact. Mucous membranes in the mouth, nose, throat, inner ear, and respiratory system may be affected by more than one of these routes of entry. Many hazardous materials adhere to and assimilate with the moist environment provided by these membranes, become trapped or lodged in the mucus, and are subsequently absorbed or ingested.

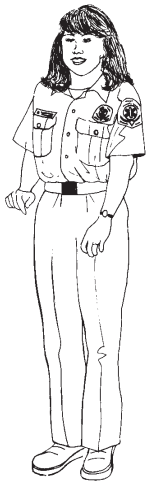
**Exhibit II-8**
**Levels of Protection**



**Level A**

**Level B**

**Level C**



**Level D**

## Chemical Protective Clothing (CPC)

Protective clothing is designed to prevent direct contact of a chemical contaminant with the skin or body of the user. There is, however, no single material that will afford protection against all substances. As a result, multilayered garments may be employed in specific situations despite their negative impact on dexterity and agility. CPC is designed to afford the wearer a known degree of protection from a known type, a known concentration, and a known length of exposure to a hazardous material, but only if it is properly fitted and worn correctly. Improperly used equipment can expose the wearer to danger. Another factor to keep in mind when selecting CPC is that most protective clothing is designed to be impermeable to moisture, thus limiting the transfer of heat from the body through natural evaporation. This is a particularly important factor in hot environments or for strenuous tasks since such garments can increase the likelihood of heat-related injuries. Research is now underway to find lightweight suits that are breathable but still protective against a wide range of chemicals. Cooling vests are sometimes used in warm weather situations to keep the body temperature normal, but with mixed results.

Essential to any protective ensemble are chemical resistant boots with steel toe and shank. Chemical resistant inner and outer layered gloves must also be worn. Compatibility charts should be consulted to determine the appropriate type of boot and gloves to use, since no one material presently provides protection against all known chemicals. Wearing multiple layers of gloves impairs dexterity and makes performing basic aspects of patient assessment (e.g., checking breathing, taking a pulse) difficult without constant practice.

The effectiveness of CPC can be reduced by three actions: degradation, permeation, and penetration. *Chemical degradation* occurs when the characteristics of the material in use are altered through contact with chemical substances or aging. Examples of degradation include cracking and brittleness, and other changes in the structural characteristics of the garment. Degradation can also result in an increased permeation rate through the garment.

*Permeation* is the process by which chemical compounds cross the protective barrier of CPC because of passive diffusion. The rate at which a compound permeates CPC is dependent on factors such as the chemical properties of the compound, the nature of the protective barrier in the CPC, and the concentration of the chemical on the surface of the protective material. Most CPC manufacturers provide charts on the breakthrough time the time it takes for a chemical to permeate the material of a protective suit for a wide range of chemical compounds.

*Penetration* occurs when there is an opening or a puncture in the protective material. These openings can include unsealed seams, buttonholes, and zippers. Often such openings are the result of faulty manufacture or problems with the inherent design of the suit. Protective clothing is available in a wide assortment of forms, ranging from fully-encapsulated body suits to gloves, hard hats, earplugs, and boot covers. CPC comes in a variety of materials, offering a range of protection against a number of chemicals. Emergency medical personnel must evaluate the properties of the chemical versus the properties of the protective material. Selection of the appropriate CPC will depend on the specific chemical(s) involved, and on the specific tasks to be performed.

## Respiratory Protection

Substantial information is available for the correct selection, training, and use of respirators. The correct respirator must be employed for the specific hazard in question. Material Safety Data Sheets (if available) often specify the type of respirator that will protect users from risks. In addition, manufacturers suggest the types of hazards against which their respirators can offer protection. OSHA has set mandatory legal minimum requirements (29 CFR (1910.134)) for respiratory protection. In addition, NIOSH has established comprehensive requirements for the certification of respiratory protection equipment.

**Personnel must be fit-tested for use of all respirators.** Even a small space between the respirator and you could permit exposure to a hazardous substance(s) by allowing in contaminated air. Anyone attempting to wear any type of respirator must be trained and drilled in its proper use. Furthermore, equipment must be inspected and checked for serviceability on a routine basis.

There are two basic types of respirators: air-purifying and atmosphere-supplying. Atmosphere-supplying respirators include self-contained breathing apparatus (SCBA) and supplied-air respirators (SAR).

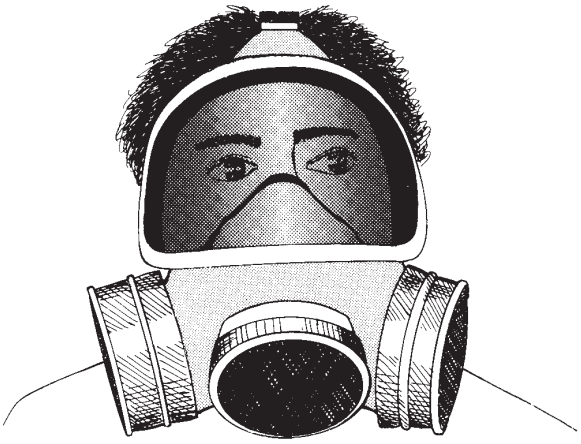
### Air-Purifying Respirators (APRs)

An air-purifying respirator purifies ambient air by passing it through a filtering element before inhalation. The major advantage of the APR system is the increased mobility it affords the wearer. However, a respirator can only be used where there is sufficient oxygen (19.5 percent) since it depends on ambient air to function. In addition, APRs should not be used when substances with poor warning properties are known to be involved or, if the agent is unknown, when environmental levels of a substance exceed the filtration capacity of the canisters.

Three basic types of APRs are used by emergency personnel: chemical cartridges or canisters, disposables, and powered air-purifiers. The most commonly used APR depends on cartridges (Exhibit II-9) or canisters to purify the air by chemical reaction, filtration, adsorption, or absorption. *Cartridges and canisters* are designed for specific materials at specific concentrations. To aid the user, manufacturers have color-coded the cartridges and canisters to indicate the chemical or class of chemicals for which the device is effective. NIOSH recommends that use of a cartridge not exceed one work shift. However, if breakthrough of the contaminant occurs first, then the cartridge or canister must be immediately replaced. After use, cartridges and canisters should be considered contaminated and disposed of accordingly.

*Disposable APRs* are usually designed for use with particulates, such as asbestos, although some are approved for use with other contaminants. These respirators are typically half-masks that cover the face from nose to chin, but do not provide eye protection. Once used, the entire respirator is usually discarded. This type of APR depends on a filter to trap particulates. Filters may also be used in combination with cartridges and canisters to provide an individual with increased protection from particulates. The use of half-mask APRs is not generally recommended by emergency response organizations.

**Exhibit II-9**
**Chemical Cartridge Air-Purifying Respirator**



*Powered Air-Purifying Respirators (PAPRs)* have the advantage of creating an improved facemask seal, thus reducing the risk of inhalation injury. Air being blown into the mask can also have a cooling affect. PAPRs come with either full facemasks or pullover hoods. Some individuals find the hooded system to be more comfortable and less claustrophobic than the mask. According to OSHA guidelines, men with beards can wear the hooded system but not the full facemask.

## Atmosphere-Supplying Respirators

Atmosphere-supplying respirators consist of two basic types: the self-contained breathing apparatus (SCBA), which contains its own air supply, and the supplied-air respirator (SAR), which depends on an air supply provided through a line linked to a distant air source. Exhibit II-10 illustrates an example of each.

### *Self-Contained Breathing Apparatus (SCBA)*

A self-contained breathing apparatus respirator is composed of a facepiece connected by a hose to a compressed air source. There are three varieties of SCBAs: open-circuit, closed-circuit, and escape. Open-circuit SCBAs, most often used in emergency response, provide clean air from a cylinder to the wearer, who exhales into the atmosphere. Closed-circuit SCBAs, also known as rebreathers, recycle exhaled gases and contain a small cylinder of oxygen to supplement the exhaled air of the wearer. Escape SCBAs provide air for a limited amount of time and should only be used for emergency escapes from a dangerous situation. One disadvantage of all SCBAs is that they are bulky and heavy, and can be used for only the period of time allowed by air in the tank.

The most common SCBA is the open-circuit, positive-pressure type. In this system, air is supplied to the wearer from a cylinder and enters the facepiece under positive pressure. In contrast to negative-pressure units, a higher air pressure is maintained inside the facepiece than outside. This affords the SCBA wearer the highest level of protection against airborne contaminants since any leakage may

**Exhibit II-10**
**Self-Contained Breathing Apparatus and Supplied-Air Respirators**

force the contaminant out. When wearing a negative-pressure-type apparatus, there is always the potential danger that contaminants may enter the facemask if it is not properly sealed. The use of a negative-pressure SCBA is prohibited by OSHA under 29 CFR (1910.120(q)(iv)) in incidents where personnel are exposed to hazardous materials.

### *Supplied-Air Respirators (SARs)*

Supplied-air respirators differ from SCBAs in that the air is supplied through a line that is connected to a source away from the contaminated area. SARs are available in both positive- and negative-pressure models. However, only positive-pressure SARs are recommended for use at hazardous materials incidents. One major advantage the SAR has over the SCBA device is that it allows an individual to work for a longer period. In addition, SARs are less bulky than SCBAs. By necessity, however, a worker must retrace his steps to stay connected to the SAR, and therefore cannot leave the contaminated work area by a different exit. SARs also require the air source to be in close proximity to the work area. In addition, personnel using an SAR must carry an immediately operable emergency escape supply of air, usually in the form of a small, compressed air cylinder, for use in case of an emergency.

## Emergency Department Personnel Decontamination

Decontamination is the process of removing or neutralizing harmful materials that have gathered on personnel and/or equipment during the response to a chemical incident. 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 facilities to which they bring the victim. Decontamination is of the utmost importance because it:

- Protects all hospital personnel by sharply limiting the transfer of hazardous materials from the contaminated area into clean zones.
- Protects the community by preventing transportation of hazardous materials from the hospital to other sites in the community by secondary contamination.
- Protects workers by reducing the contamination and resultant permeation of, or degradation to, their protective clothing and equipment.
- Protects other patients already receiving care at the hospital.

This section only addresses the steps necessary for dealing with worker decontamination. Patient decontamination will be addressed in Section III, *Patient Management*. It should be stressed that to carry out proper decontamination, personnel must have received at least the same degree of training as required for workers who respond to hazardous materials incidents. The design of the decontamination process should take into account the degree of hazard and should be appropriate for the situation. For example, a nine-station decontamination process need not be set up if only a bootwash station would suffice.

Avoiding contact is the easiest method of decontamination that is, not to get the material on the worker or his protective equipment in the first place. However, if contamination is unavoidable, then proper decontamination or disposal of the worker s outer gear will be necessary. Segregation and proper disposal of the outer gear in a polyethylene bag or steel drum will be necessary until thorough decontamination is completed. With extremely hazardous materials, it may be necessary to dispose of equipment as well.

Physical decontamination of protective clothing and equipment can be achieved by several different means. These all include the systematic removal of contaminants by washing, usually with soap and water, and then rinsing. In rare cases, the use of solvents may be necessary. There is a trend toward using disposable clothing (e.g., suits, boots, gloves) and systematically removing these garments in a manner that precludes contact with the contaminant. The appropriate decontamination procedure will depend on the contaminant and its physical properties. Thoroughly researching the chemicals involved and their properties, or consultation with an expert, is necessary to make these kinds of decisions.

Care must be taken at all times to ensure that the decontamination methods being used do not introduce fresh hazards into the situation. In addition, the residues of the decontamination process must be treated as hazardous wastes. The decontamination stations and process should be confined to the Contamination Reduction Zone (see Exhibit II-11). Steps for personnel decontamination are outlined in Exhibit II-12, and the technical decontamination process is discussed below.

### Technical Decontamination Process for Hospital Personnel

*Personnel should remove protective clothing in the following sequence.*

1. **Remove tape (if used) securing gloves and boots to suit.**
2. **Remove outer gloves, turning them inside out as they are removed.**
3. **Remove suit, turning it inside out and folding it downward. Avoid shaking.**
4. **Remove boot/shoe cover from one foot and step over the clean line. Remove other boot/shoe cover and put that foot over the clean line.**
5. **Remove mask. The last person removing his/her mask may want to wash all masks with soapy water before removing his/her suit and gloves. Place the masks in plastic bag and hand the bag over the clean line for placement in second bag held by another staff member. Send bag for decontamination.**
6. **Remove inner gloves and discard them in a drum inside the dirty area.**
7. **Secure the dirty area until the level of contamination is established and the area is properly cleaned.**
8. **Personnel should then move to a shower area, remove undergarments and place them in a plastic bag. Double-bag all clothing and label bags appropriately.**
9. **Personnel should shower and redress in normal working attire and then report for medical surveillance.**

## COMMUNICATIONS

Effective communications are essential to maintaining incident control. These include a dedicated radio frequency and a sufficient number of radios for distribution to all participating agencies. Another network should link the onsite command post to support groups, such as the Poison Control Center and the Health Department. Other networks that may have to be activated include one linking the hospital emergency department to EMTs and one dedicated for use by the teams in the Exclusion and Contamination Reduction Zones. When an Incident Command System is activated, one person is often assigned to manage communications.

## Exhibit II-11
## NIOSH/OSHA/USCG/EPA Recommended Zones

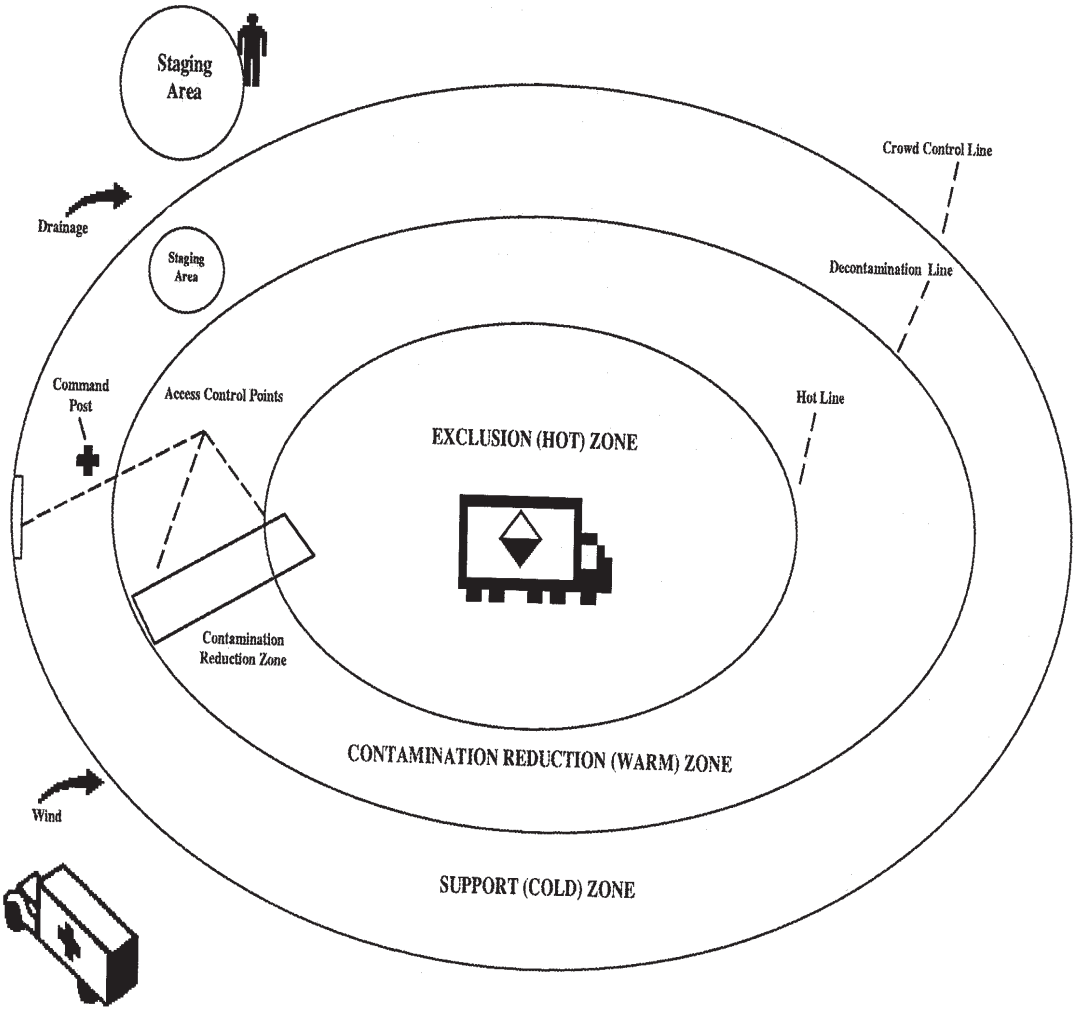
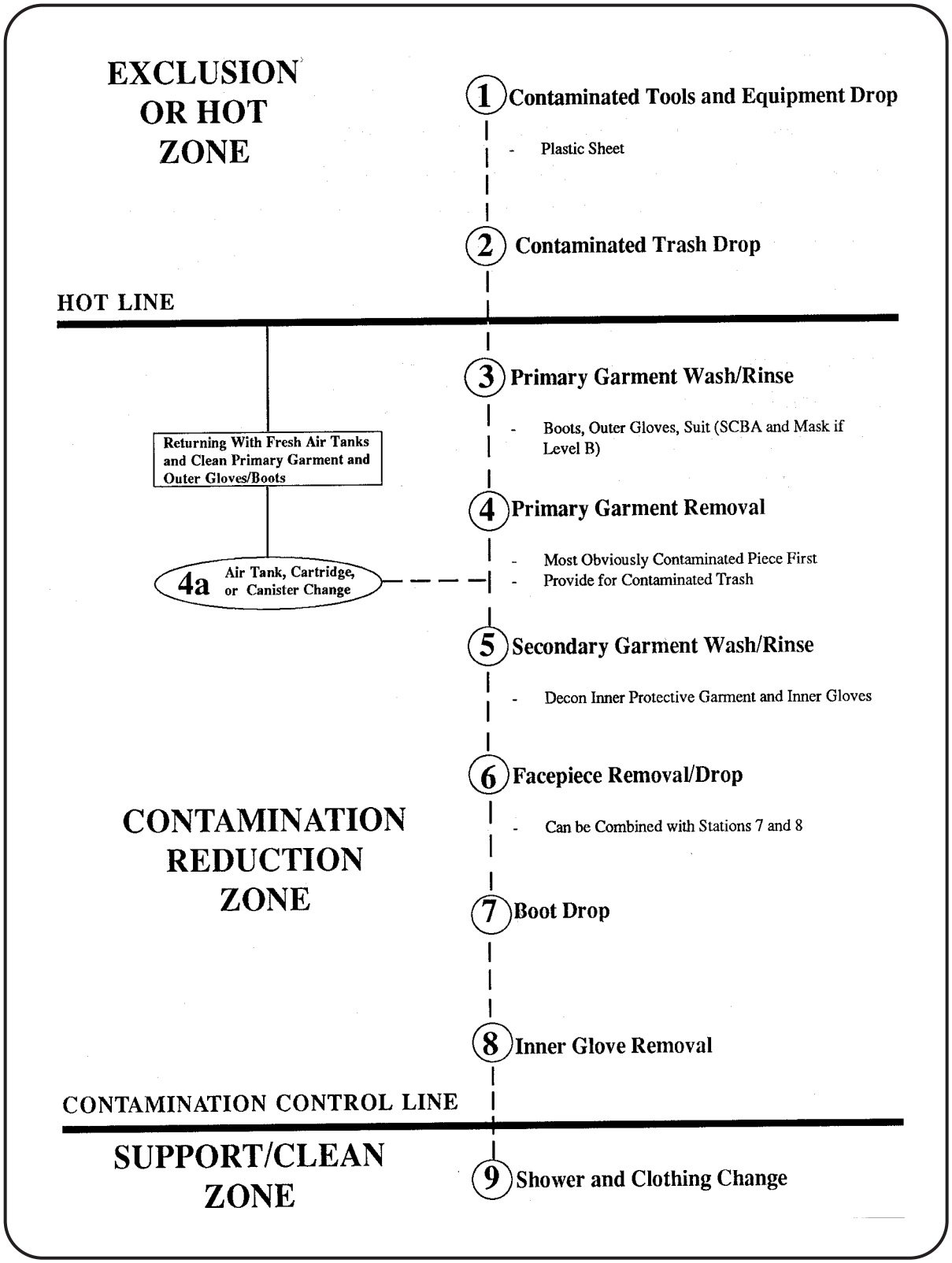


**Exhibit II-12**
**Nine-Step Personnel Decontamination Plan**



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Growing concern about the proper treatment of chemically contaminated patients has outpaced adequate guidance on the subject. However, definitive work has been done on cases that bear similar characteristics (e.g., radioactive exposure), and some of the same principles apply. Many of these principles are outlined in the article  Emergency Department Radiation Accident Protocol by R.B. Leonard and R.C. Ricks, published in the September 1980 issue of *Annals of Emergency Medicine.* Further information on radiation response procedures is contained in *Hospital Emergency Department Management of Radiation Accidents* by R.C. Ricks, prepared for the Federal Emergency Management Agency.

When a hospital receives a call that a patient exposed to hazardous materials is being transported to its facility, a planned course of action should be implemented. Steps in the protocol must be practiced before a hazardous materials emergency occurs. Emergency department personnel should know their responsibilities and how to perform them, and all required equipment should be immediately accessible.

Individuals receiving a potential hazardous materials call should obtain as much information as possible. A checklist should be developed and made available for all telephone or radio communication centers. Information that will aid in initiating appropriate actions includes:

- Type and nature of incident
- Caller s telephone number
- Number and ages of patients
- Signs and symptoms being experienced by the patients
- Nature of injuries
- Name of chemical(s) involved, including correct spelling
- Extent of patient decontamination in the field
- Estimated time of arrival

After the above information is received, a predesignated resource center (e.g., regional Poison Control Center, ATSDR) should be contacted for information regarding definitive care procedures. This should include the need for decontamination and what methods should be used. Communications should be kept open with onsite response personnel to obtain as much advance information as possible.

If incident notification comes through other than usual emergency communication channels, the call should be verified before a hazardous materials response plan is initiated. Ambulance personnel should be notified of any special approach or entrance to the emergency department and also advised

not to bring the patient into the emergency department until he or she has been assessed by appropriate emergency department staff.

Often patients contaminated by hazardous materials are brought into the emergency department unannounced or not through regular EMS channels. This could be an ambulatory patient or an individual transported by private vehicle. The ideal response to this situation is to call the fire department or a hazmat team that is properly trained and equipped to come to the hospital and set up a decontamination area outside the ambulance entrance. In any event, these individuals should be isolated from other patients and assessed and decontaminated as soon as possible. Preplanning with the fire department and/or hazmat team should determine the location, equipment needs, and logistics for decontamination outside of the hospital during all weather conditions.

## Emergency Department Preparation

Every member of the emergency department should be familiar with the hospital s hazardous materials response plan and be required to participate in scheduled drills. A written copy of the plan should also be kept in a central location in the emergency department for quick reference. Preparation for arrival of a contaminated patient should include notification of all services involved, preparation of a decontamination area, and suiting up of the decontamination team.

### Emergency Department Mobilization

The person receiving a call of an incoming victim(s) should notify the Nursing Supervisor or other designated individual, who will in turn notify the appropriate personnel according to the hospital s response plan. The hospital operator should be instructed to notify security and maintenance, and the nurse on duty should contact the predesignated resource center.

### Decontamination Area Preparation

Any victim of a hazardous materials incident must be considered to be contaminated until demonstrated otherwise. Therefore, the route from the emergency entrance to the Decontamination Area may also become contaminated and all persons along that route should be removed by security personnel prior to the arrival of the contaminated patient. Ideally, this area should be protected with a barrier of plastic or paper sheeting taped securely to the floor. Care should be exercised in walking on plastic sheeting because it can become very slippery when wet.

Security personnel should be stationed at the main entrance to the emergency department, close to the Decontamination Area, to prevent unauthorized entry, to control the entry of contaminated patients into the department, and to direct the vehicle(s) transporting the patient(s) to the appropriate area. A reception station should be set up just outside the emergency department entrance, where arriving patients can be screened for adequate decontamination before entering.

A decontamination area should be large enough to facilitate decontamination of more than one patient and to accommodate the many personnel involved in patient treatment and contamination reduction. The ventilation system should either be separate from the rest of the hospital or turned off to prevent the spread of airborne contaminants through heating and air conditioning ducts to other

parts of the facility. If the ventilation system is shut off during the handling of a contaminated victim in an enclosed area, the emergency department staff could be endangered. To address this, OSHA regulations on atmospheric monitoring (29 CFR (1910.120)(q)(3)(iv)) should be followed, especially if air-purifying respirators are used.

Weather permitting, the best place to evaluate and initially treat contaminated patients is outside, where ambient ventilation will keep airborne cross-exposure low. Some hospitals have radiation decontamination facilities that can be used with minor changes. An outside or portable decontamination system is a viable substitute and would aid in preventing contamination of the emergency department and other patients. A practical alternative for facilities with limited resources is to have a warm shower nozzle, soap, a wading pool, and plastic garbage bags in a predesignated area outside the back door to the emergency department. The patient may be able to remove his or her own contaminated clothing, place it in a double bag, and do his or her own soap and water decontamination. A partial tent or curtain can provide for patient privacy. Under most circumstances, ordinary hospital gowns, plastic goggles, and plain latex gloves will adequately protect hospital staff if they have to assist the patient in removing soaked clothing, washing exposed skin and hair, or performing eye irrigation. With large amounts of concentrated corrosives or very oily materials, such as pesticides, disposable chemical protective clothing and unmilled nitrile gloves offer additional protection. If it is anticipated that your facility is likely to receive heavily contaminated patients who have not received prior decontamination, then it may be advisable to purchase appropriate protective gear and to fit and train emergency department staff in its use. However, no person should wear and use specialized PPE, especially respiratory protective gear, without prior training.

To prevent unnecessary contamination, all nonessential and nondisposable equipment should be removed from the decontamination area. Door knobs, cabinet handles, light switches, and other surfaces that have contact with hands should be taped, and the floors should be covered with plastic or paper sheeting. The floor covering should be securely taped to prevent slippage, and the entrance to the room marked with a wide strip of colored tape to indicate a contaminated area. Personnel should not enter the area unless properly protected, and no personnel or equipment should leave the area until properly decontaminated. A clean member of the staff should stand on the clean side of the entrance to hand in supplies and receive medical specimens.

The essential requirements for any decontamination task are:

- A safe area to keep a patient while undergoing decontamination
- A method for washing contaminants off a patient
- A means of containing the rinsate
- Adequate protection for personnel treating the patient
- Disposable or cleanable medical equipment to treat the patient

## Decontamination Team Preparation

A decontamination team should be predesignated and trained in appropriate personal protection equipment and procedures. The team should consist of:

- Emergency department physicians
- Emergency department nurses and aides
- A trauma surgeon, if injuries are present
- Support personnel
  - Nursing Supervisor
  - Occupational Health and Safety Officer
  - Security
  - Maintenance
  - Recorder

The decontamination team should be equipped with personal protective clothing (as discussed in Section II) for whatever level is deemed appropriate for the substance(s) involved. This may be determined by consulting reference guidebooks, websites, database networks, telephone hotlines, or a predesignated resource center (e.g., the regional Poison Control Center).

Appropriate dress for the decontamination team should include:

- A scrub suit.
- Plastic shoe covers.
- Disposable chemical protective clothing with built-in hood and booties, and with hood taped at the neck.
- Polyvinyl chloride (PVC) gloves taped to sleeves.
- Respiratory protection, as appropriate (see Section II).
- Multiple layers of surgical gloves, neoprene or disposable nitrile gloves, with the bottom layer taped; should be changed whenever torn.
- Protective eyewear.

A 2-inch-wide piece of masking tape with the team member s name written on it, and placed on the back of the protective suit, will assist team members in communicating.


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## Patient Arrival

The emergency physician-in-charge or an emergency department nurse should meet the ambulance upon arrival and assess the condition of the patient(s) as well as the degree of contamination. The recorder should note on a diagram of the body the areas found by the physician to be contaminated. Personnel should keep in mind that the actual contamination may be (or become) a life-threatening condition, and triage procedures should be initiated at this point, if necessary. During initial patient assessment and stabilization, contamination reduction should simultaneously be performed. This consists of cutting away or otherwise removing all suspected contaminated clothing, including jewelry and watches, and brushing or wiping off any contamination. Care should be taken to protect any open wounds from contamination. Emergency department personnel should make every effort to avoid contact with any potentially hazardous substance(s).

Ideally, decontamination should be performed before patient transport; however, field decontamination facilities are limited and emergency department personnel should consider that all hazardous materials patients need decontamination unless information has been received indicating that it is not necessary (e.g., in cases of carbon monoxide exposure). If a patient s clothing was not removed at the incident site, it should be removed outside the ambulance but before entry into the emergency department. This will reduce further exposure to the patient and lessen the extent of contamination introduced into the emergency department. Contaminated clothing should be double-bagged in plastic bags, sealed, and labeled. The decontamination team should bring the prepared stretcher to the ambulance, transfer the patient, and take him or her directly to the Decontamination Area along the predesignated route.

Priority should be given to the fundamentals of emergency treatment airway, breathing, and circulation simultaneous with contamination reduction. Once life-threatening matters have been addressed, emergency department personnel can then direct their attention to thorough decontamination and secondary patient assessment. Identification of the hazardous materials involved can be simultaneously performed by other personnel. It is important to remember that appropriate personal protective clothing must be worn until personnel are no longer in danger.

## Patient Decontamination

The basic purpose of decontamination is to reduce external contamination, contain the contamination present, and prevent the further spread of potentially dangerous substances. In other words, remove what you can and contain what you can t. **Effective decontamination consists of making the patient As Clean As Possible (ACAP). This means that the contamination has been reduced to a level that is no longer a threat to the patient or to the responder.**

With a few exceptions, intact skin is more resistant to hazardous materials than injured flesh, mucous membranes, or eyes. Therefore, decontamination should begin at the head of the patient and proceed downward with initial attention paid to contaminated eyes and open wounds. Once wounds have been cleaned, care should be exercised so that they are not recontaminated. This can be aided by covering the wounds with a waterproof dressing. For some chemicals, such as strongly alkaline substances, it may be necessary to flush exposed skin and eyes with water or normal saline for an extended period of time.

External decontamination should be performed using the least aggressive methods. Mechanical or chemical irritation to the skin should be limited to prevent damage to the epidermal layer, which results in increased permeability. The skin of young children is particularly sensitive and should be treated accordingly. Contaminated areas should be gently washed under a spray of warm (never hot) tap water, using a sponge and a mild soap. If decontamination is performed outside, care must be taken to avoid hypothermia; young children are particularly sensitive to cold stress. All run-off from decontamination procedures should be collected for proper disposal.

The first priority in the decontamination process should be treatment of contaminated open wounds. These areas allow for rapid absorption of hazardous materials. Wounds should be irrigated with copious amounts of normal saline. Deep debridement and excision should be performed only when particles or pieces of material have been embedded in the tissues. Decontamination of eyes should also take high priority. Gentle irrigation of the eyes should be performed with the stream of normal saline diverted away from the medial canthus so that it does not force material into the lacrimal duct. Contaminated nares and ear canals should also be gently irrigated, with frequent suction to prevent any material being forced deeper into those cavities. Washing with soap and tepid water, including the hair, is usually all that is needed to remove contamination. Hot water, stiff brushes, or vigorous scrubbing should seldom be used because they cause vasodilation and abrasion. This increases the chances for absorption of hazardous materials through the skin.

Decontamination of young children poses particular problems because they are usually frightened and may not understand what is happening. If a parent is available and can accompany the child through decontamination, this may be desirable. If not, a nurse should be assigned to stay with the child.

## Considerations for Patient Treatment

The primary goals for emergency department personnel in handling a contaminated individual include cessation of patient exposure, patient stabilization, and patient treatment all without jeopardizing their own safety. Termination of exposure can best be accomplished by removing the patient from the incident area and by removing contaminants from the patient.

In treating patients, personnel should consider the chemical-specific information received from the hazardous materials response resources. In multiple patient situations, proper triage procedures should be implemented. Symptoms and signs being experienced by patients should be treated as appropriate and when conditions allow. The sooner a patient becomes decontaminated the sooner he or she can be treated as a normal patient and protective measures reduced or downgraded. Recommendations from the designated Poison Control Center and orders from the attending physician should be carefully followed. Invasive procedures, such as IVs or intubation, should be used only for life-threatening conditions until decontamination is performed. Patients should be frequently reassessed and monitored because many hazardous materials have latent physiological effects.


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## Information on Materials Involved

Identification of the material(s) involved in a hazardous materials incident should be determined as early in the process as possible. Using resources outlined elsewhere in this section, and in Section II under Hazard Recognition, personnel should identify and obtain detailed information involving treatment, decontamination procedures, and possible adverse health effects of the specific chemical(s) involved. Needed information includes:

- Chemical name of substance(s) involved
- Form of the material (solid, liquid, gas)
- Length of exposure
- Route(s) of exposure
- Possible adverse health effects
- Recommended treatment or antidote therapy
- PPE required
- Decontamination procedures

The importance of getting a rapid but comprehensive overview on an unknown substance cannot be overemphasized. Based on past hazmat incidents, NIOSH and EPA recommend that Level B protection is the minimum level to be worn when entering an area containing unknown substances. However, if the substance in question is suspected to involve the skin as a route of exposure or is otherwise noted to be dangerous by absorption, corrosion, and the like, Level A protection should be worn because it provides additional skin protection.

## Removal of Patient from Decontamination Room

After the patient has been decontaminated, place a clean piece of plastic on the floor for the patient and staff to use when exiting the clean area. If the patient is not ambulatory, a clean stretcher or wheelchair should be brought to the doorway by an individual who has not been exposed. After the patient is transferred to the clean area, the physician can perform a physical examination and initiate routine patient management. The patient can be discharged home or admitted to the hospital, depending on his or her clinical condition. The attending staff must remember that since exposure to some substances can result in serious delayed effects, sustained observation and monitoring may be required.

## Community Education and Briefing

During a hazardous materials incident, the emergency department will be used as a source of information by the community and the media. A plan must be in place to deal with information requests, whether received by phone or by onsite media representatives. It is essential that all information be delivered by a knowledgeable person and be coordinated with the agency handling the event in the field. In the absence of such coordination, misleading or inaccurate information may be released which may worsen public reaction to an incident. Above all, it is essential that patient confidentiality be respected. The emergency department may opt to defer all information requests to other involved agencies, such as the regional Poison Control Center.

## Critique

As soon as possible following a hazardous materials incident, all participating units should send knowledgeable representatives to review the measures that were taken by each unit or agency. The purpose of this review is to examine which activities succeeded and which did not, and to evaluate the overall coordination effort with an aim toward making necessary improvements.

## Patient Management Under Mass Casualty Conditions Involving Hazardous Chemicals

Basic medical procedures in a large-scale hazardous materials incident are not substantially different from life-saving measures in other mass casualty disasters. Primary attention should focus on the ABC fundamentals of emergency care, with decontamination performed at the same time. A chemical disaster may overwhelm any one hospital, particularly if it occurs along with another disaster such as an earthquake. Hospitals need to preplan what steps to take if they are unable to handle the number of hazmat patients.

## Critical Incident Stress Management

Situations involving large numbers of ill or injured individuals, and risks of harm to the responder(s), are sources of critical incident stress. To minimize the occurrence of acute or long-term psychological consequences in response personnel, stress debriefing sessions should be held shortly after the incident is terminated. Acute stress reactions recognized during the incident should be immediately addressed by qualified peer debriefers or other qualified mental health professionals.


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# Appendix A

## Hazardous Materials Classification Systems

## National Fire Protection Association, 704M System

The marking system designed by the National Fire Protection Association identifies hazard characteristics of materials at terminal and industrial sites. It uses a diamond divided into four quadrants, with each quadrant representing a different characteristic, as explained below.

The risk level ratings, ranging from four (highest risk) to zero (minimum risk), are based upon protective equipment normally used by firefighters.

### Health (Blue)

Health hazards in firefighting generally result from a single exposure, which may vary from a few seconds up to an hour. Only hazards arising out of an inherent property of the material are considered. It should be noted, however, that the physical exertion demanded in firefighting or other emergency conditions tends to intensify the effects of any exposure.

**Risk level 4:** Materials too dangerous to human health to expose firefighters. A few whiffs of the vapor could cause death or the vapor or liquid could be fatal on penetrating the firefighter s normal full protective clothing. The normal full protective clothing and breathing apparatus available to the average fire department will not provide adequate protection against inhalation or skin contact with these materials.

**Risk level 3:** Materials extremely hazardous to health, but areas may be entered with extreme care. Full protective clothing including self-contained breathing apparatus, coat, pants, gloves, and boots, with bands around the legs, arms, and waist should be provided. No skin surface should be exposed.

**Risk level 2:** Materials hazardous to health, but areas may be entered freely with full facemask self-contained breathing apparatus that also provides eye protection.

**Risk level 1:** Materials only slightly hazardous to health. It may be desirable to wear self-contained breathing apparatus.

**Risk level 0**: Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.

### Flammability (Red)

Susceptibility to burning is the basis for assigning risk levels within this category. The method of attacking the fire is influenced by the material s susceptibility factor.

**Risk level 4:** Very flammable gases or very volatile flammable liquids. Shut off flow and keep cooling water streams on exposed tanks or containers.

**Risk level 3:** Materials that can be ignited under almost all normal temperature conditions. Water may be ineffective because of the low flash point.

**Risk level 2:** Materials that must be moderately heated before ignition will occur. Water spray may be used to extinguish the fire because the material can be cooled below its flash point.

**Risk level 1:** Materials that must be preheated before ignition will occur. Water may cause frothing if it gets below the surface of the liquid and turns to steam. However, water fog gently applied to the surface will cause a frothing that will extinguish the fire.

**Risk level 0:** Materials that will not burn.

## Reactivity/Stability (Yellow)

The assignment of degrees in the reactivity category is based upon the susceptibility of materials to release energy either by themselves or in combination with water. Fire exposure is one of the factors considered, along with conditions of shock and pressure.

**Risk level 4:** Materials that (in themselves) are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures. Includes materials that are sensitive to mechanical or localized thermal shock. If a chemical with this hazard rating is in an advanced or massive fire, the area should be evacuated.

**Risk level 3:** Materials that (in themselves) are capable of detonation or of explosive decomposition or reaction that require a strong initiating source that must be heated under confinement before initiation. Includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures, or that react explosively with water without requiring heat or confinement. Firefighting should be done from an explosive-resistant location.

**Risk level 2:** Materials that (in themselves) are normally unstable and readily undergo violent chemical change, but do not detonate. Includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures, or that can undergo violent chemical change at elevated temperatures and pressures. Also includes those materials that may react violently with water or that may form potentially explosive mixtures with water. In advanced or massive fires, firefighting should be done from a safe distance or from a protected location.

**Risk level 1:** Materials that (in themselves) are normally stable but that may become unstable at elevated temperatures and pressures or that may react with water with some release of energy, but not violently. Caution must be used in approaching the fire and applying water.

**Risk level 0:** Materials that (in themselves) are normally stable even under fire exposure conditions and that are not reactive with water. Normal firefighting procedures may be used.

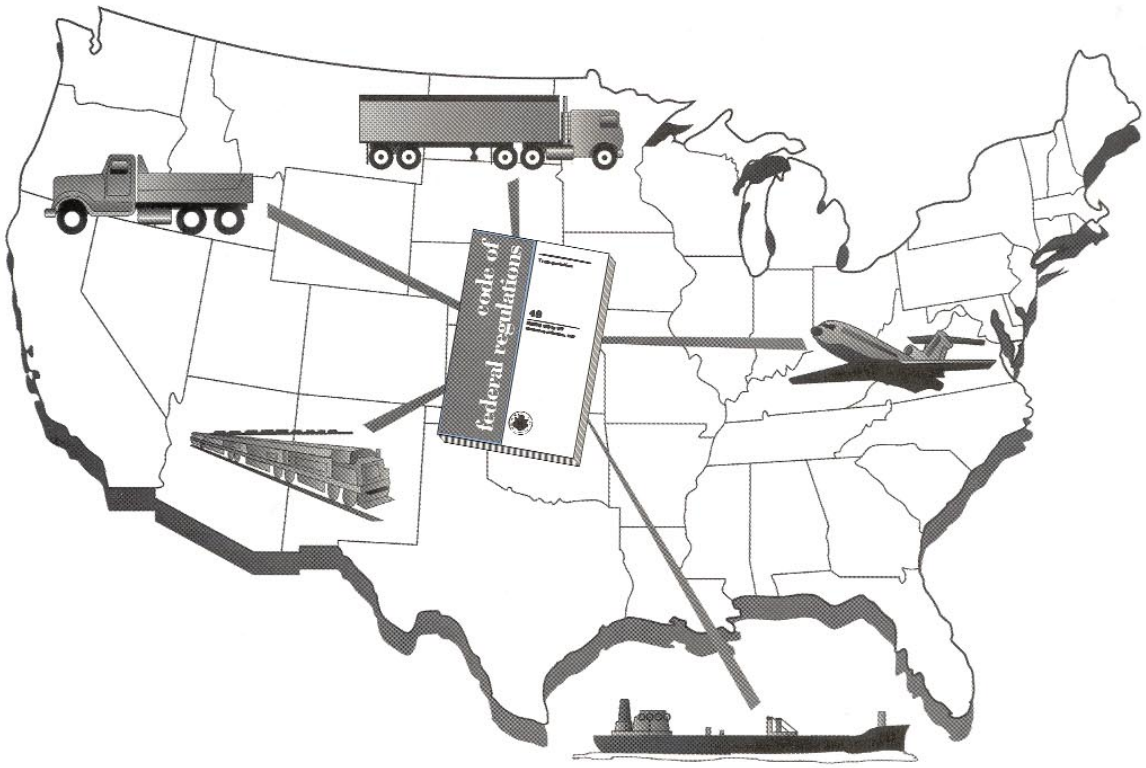
## Special Information (White)

The quadrant includes information on specific characteristics of the material (e.g., reactivity with water, tendency to oxidize).

U.S. Department of Transportation
**Research and Special Programs Administration**

# DOT CHART 11

## Hazardous Materials Marking, Labeling & Placarding Guide




Refer to 49 CFR, Part 172:

Marking - Subpart D

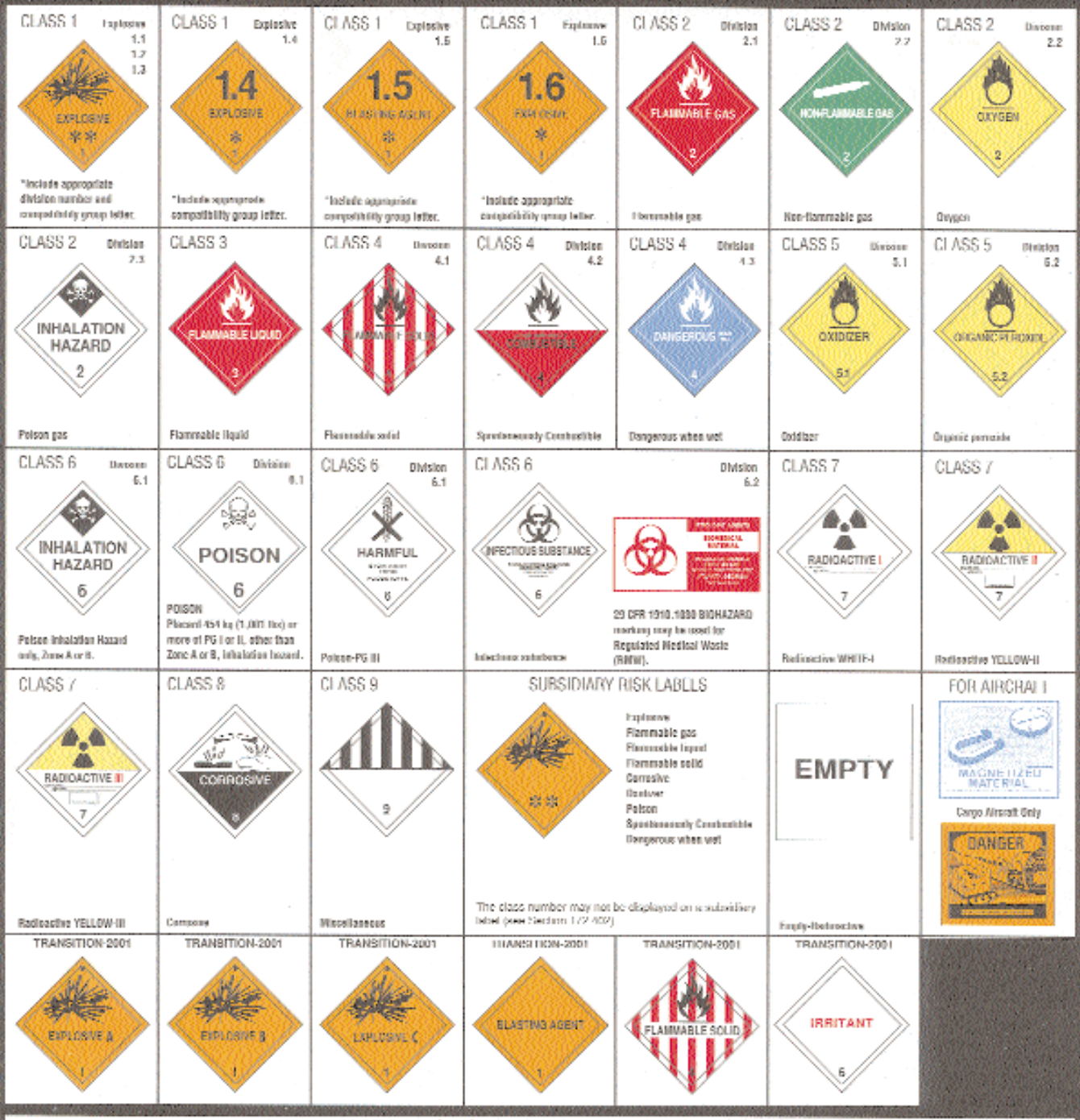
Labeling - Subpart E

Placarding - Subpart F

Emergency Response - Subpart G

**NOTE:** **This document is for general guidance only and must not be used to determine compliance with 49 CFR, Parts 100-185.**

# Hazardous Materials Warning Labels




## HAZARDOUS MATERIALS MARKINGS


Keep a copy of the North American Emergency Response

# Hazardous Materials Warning Placards

CLASS 1


EXPLOSIVES
*Enter Division Number 1.1, 1.2, or 1.3 and compatibility group letter, when required. Placard any quantity.

CLASS 1


EXPLOSIVES 1.4
*Enter compatibility group letter, when required. Placard 454 kg (1,001 lbs) or more.

CLASS 1


EXPLOSIVES 1.5
*Enter compatibility group letter, when required. Placard 454 kg (1,001 lbs) or more.

CLASS 1


EXPLOSIVES 1.6
*Enter compatibility group letter, when required. Placard 454 kg (1,001 lbs) or more.

CLASS 2


OXYGEN
Placard 454 kg (1,001 lbs) or more gross weight of either compressed gas or refrigerated liquid.

CLASS 2


FLAMMABLE GAS
Placard 454 kg (1,001 lbs) or more.

CLASS 2


NON-FLAMMABLE GAS
Placard 454 kg (1,001 lbs) or more gross weight.

CLASS 2 Division 2.3


POISON GAS
Placard any quantity.

CLASS 3


FLAMMABLE
Placard 454 kg (1,001 lbs) or more.

CLASS 3


GASOLINE
May be used in the place of FLAMMABLE placard displayed on a cargo tank or a portable tank being used to transport gasoline by highway.

CLASS 3


COMBUSTIBLE
Placard a combustible liquid when transported in bulk. See §172.504(f)(2)for use of FLAMMABLE placard in place of COMBUSTIBLE placard.

CLASS 3


FUEL OIL
May be used in place of COMBUSTIBLE on a placard displayed on a cargo tank or portable tank being used to transport by highway fuel oil not classed as a flammable liquid.

CLASS 4


FLAMMABLE SOLID
Placard 454 kg (1,001 lbs) or more.

CLASS 4


SPONTANEOUSLY COMBUSTIBLE
Placard 454 kg (1,001 lbs) or more.

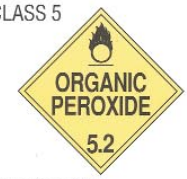
CLASS 4


DANGEROUS WHEN WET
Placard any quantity of Division 4.3 material.

CLASS 5


OXIDIZER
Placard 454 kg (1,001 lbs) or more.

CLASS 5




ORGANIC PEROXIDE
Placard any quantity, TYPE B, temperature controlled. Placard 454 kg (1,001 lbs) or more other than TYPE B, temperature controlled.

CLASS 6


POISON-INHALATION HAZARD
Placard any quantity of 6.1, Zone A or B inhalation hazard only.


POISON
Placard 454 kg (1,001 lbs) or more of PGI or II, other than Zone A or B inhalation hazard.


KEEP AWAY FROM FOOD
Placard 454 kg (1,001 lbs) or more of PG III.

CLASS 7


RADIOACTIVE
Placard any quantity - packages bearing RADIOACTIVE YELLOW-III labels only. Certain low specific activity radioactive materials in "exclusive use" will not bear the label, but the Radioactive placard is required for exclusive use shipments of low specific activity material and surface contaminated objects transported in accordance with §173.427 (b)(3) or (c).

CLASS 8


CORROSIVE
Placard 454 kg (1,001 lbs) or more.

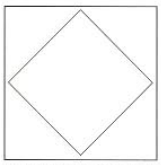
CLASS 9


MISCELLANEOUS
Not required for domestic transportation. A bulk packaging containing a Class 9 material must be marked with the appropriate ID number displayed on a Class 9 placard, an orange panel or a white square-on-point display.


DANGEROUS
A freight container, unit load device, transport vehicle, or rail car which contains non-bulk packagings with two or more categories of hazardous materials that require different placards specified in Table 2 may be placarded with DANGEROUS placards instead of the specific placards required for each of the materials in Table 2. However, when 1,000 kg (2,205 lbs) or more of one category of material is loaded at one loading facility, the placard specified in Table 2 must be applied.

SUBSIDIARY RISK PLACARD


Class numbers do not appear on a subsidiary risk placard.



White square background required for placard for highway route controlled quantity radioactive material and for rail shipment of certain explosives and poisons, and for flammable gas in a DOT 113 tank car (see §§172.507 and 172.510).

**UN or NA Identification Numbers**

PLACARDS OR ORANGE PANELS


and

Appropriate Placard must be used.


MUST BE DISPLAYED ON: (1) Tank Cars, Cargo Tanks, Portable Tanks, other Bulk Packaging, and (2) On vehicle or containers containing large quantities (8,820) lbs.) In non-bulk packages of only a single hazardous material, and certain quantities (2,205) of a material poisonous by inhalation in Hazard Zone A or B, having the same proper shipping name and identification number.

**Guidebook handy! Response begins with identification!**

# General Guidelines on Use of Warning Labels and Placards

## LABELS

See 49 CFR, Part 172, Subpart E for complete labeling regulations.

- Until October 1, 1999, labels for materials poisonous by inhalation that conform to the requirements of the HMR in effect on September 30, 1997, may be used to satisfy the requirements of Subpart E.
- Those labels in boxes marked "TRANSITION 2001" on the chart are not authorized for use under Subpart E. (NOTE: these labels may be used IF they were affixed to a package offered for transportation and transported prior to October 1, 2001, and the package was filled with hazardous materials prior to October 1, 1991.)
- For classes 1,2,3,4,5,6 and 8, text indicating a hazard (e.g., "CORROSIVE") IS NOT required on a label. The label must otherwise conform to Subpart E [Section 172.405].
- Any person who offers a hazardous material for transportation MUST label the package, if required [Section 172.400(a)].
- The Hazardous Materials Table [Section 172.101] identifies the proper label(s) for the hazardous material listed.
- When required, labels must be printed on or affixed to the surface of the package near the proper shipping name [Section 172.406(a)].
- When two or more labels are required, they must be displayed next to each other [Section 172.406(c)].
- Labels may be affixed to packages when not required by regulations, provided each label represents a hazard of the material contained in the package [Section 172.401].

## PLACARDS

See 49 CFR, Part 172, Subpart F for complete placarding regulations.

- Until October 1, 2001, placards for materials poisonous by inhalation, by all modes of transportation, may be used that conform to specifications for placards (1) in effect on September 30, 1991, (2) specified in the December 21, 1990 final rule, (HM-181) or (3) specified in the July 22, 1997 final rule (HM-206).
- All of the placards appearing on the Hazardous Materials Warning Placards chart may be used to satisfy the placarding requirements contained in Subpart F.
- Each person who offers for transportation or transports any hazardous material subject to the Hazardous Materials Regulations shall comply with all applicable requirements of Subpart F.
- Placards may be displayed for a hazardous material even when not required, if the placarding otherwise conforms to the requirements of Subpart F.
- For other than Class 7 or the OXYGEN placard, text indicating a hazard (e.g., "CORROSIVE") is not required on a placard [Section 172.519(b)].
- Any transport vehicle, freight container, or rail car containing any quantity of material listed in Table 1 must be placarded [Section 172.504].
- When the gross weight of all hazardous materials in non-bulk pkgs. covered in Table 2 is less than 454 kg (1,001 lbs), no placard is required on a transport vehicle or freight container [Section 172.504].

Effective October 1, 1994, and extending through October 1, 2001, these placards may be used for HIGHWAY TRANSPORTATION ONLY.


Illustration numbers in each square refer to Tables 1 and 2 below.

## Inhalation Hazard Materials


§172.540


§172.555


§172.313

Materials which meet the inhalation toxicity criteria have additional "communication standards" prescribed by the HMR. First, the words "Poison-Inhalation Hazard" must be entered on the shipping paper, as required by Section 172.203(m)(3). Second, packagings must be marked "Inhalation Hazard" or, alternatively, when the words "Inhalation Hazard" appear on the label or placard, the "Inhalation Hazard" marking is not required on the package. Transport vehicles, freight containers, portable tanks and unit load devices that contain a poisonous material subject to the "Poison-Inhalation Hazard" shipping description, must be placarded with a POISON INHALATION HAZARD or POISON GAS placard, as appropriate. This shall be in addition to any other placard required for that material in Section 172.504.

**Table 1 (Placard any quantity)**

| Hazard class or division | Placard name |
|---|---|
| 1.1 | EXPLOSIVES 1.1 |
| 1.2 | EXPLOSIVES 1.2 |
| 1.3 | EXPLOSIVES 1.3 |
| 2.3 | POISON GAS |
| 4.3 | DANGEROUS WHEN WET |
| 5.2 (Organic peroxide, Type B, liquid or solid, temperature controlled) | ORGANIC PEROXIDE |
| 6.1 (Inhalation Hazard, Zone A or B) | POISON INHALATION HAZARD |
| 7 (Radioactive Yellow III label only) | RADIOACTIVE |

**Table 2 (Placard 1,001 pounds or more)**

| | |
|---|---|
| 1.4 | EXPLOSIVES 1.4 |
| 1.5 | EXPLOSIVES 1.5 |
| 1.6 | EXPLOSIVES 1.6 |
| 2.1 | FLAMMABLE GAS |
| 2.2 | NON-FLAMMABLE GAS |
| 3 | FLAMMABLE |
| Combustible Liquid | COMBUSTIBLE |
| 4.1 | FLAMMABLE SOLID |
| 4.2 | SPONTANEOUSLY COMBUSTIBLE |
| 5.1 | OXIDIZER |
| 5.2 (Other than organic peroxide, Type B, liquid or solid, temperature controlled) | ORGANIC PEROXIDE |
| 6.1 (PG I or II, other than Zone A or B inhalation hazard) | POISON |
| 6.1 (PG III) | KEEP AWAY FROM FOOD |
| 8.2 | NONE |
| 8 | CORROSIVE |
| 9 | CLASS 9 |
| ORM-D | NONE |

For complete details, refer to one or more of the following:

- Code of Federal Regulations, Title 49, Transportation, Parts 100-185. [All modes]
- International Civil Aviation Organization (ICAO) Technical Instructions for Safe Transport of Dangerous Goods by Air [Air]
- International Maritime Organization (IMO) Dangerous Goods Code [Water]
- Transportation of Dangerous Goods Regulations of Transport Canada. [All Modes]


U.S. Department of Transportation
**Research and Special Programs Administration**

*Copies of this Chart can be obtained by writing*
**OHMIT/DHM-51, Washington, D.C. 20590**
*or*
Phone: **202-366-4900**
E mail: **training@rspa.dot.gov**
Web site: **http//hazmat.dot.gov**



CHART 11
REV. JULY 1998

## Material Safety Data Sheets

The Material Safety Data Sheet (MSDS) has become a major source of chemical information. It is the key document used to provide hazard information to employees and can become an invaluable tool for emergency response personnel when used in a chemical emergency.

The Occupational Safety and Health Administration s (OSHA) Hazard Communication Standard (29 CFR 1910.1200) requires all manufacturers of pure chemicals and/or mixtures to evaluate their products and relate, via MSDSs, any hazards that may be encountered while handling these materials. This standard is intended for all workplaces, manufacturing and nonmanufacturing alike. The Environmental Protection Agency s (EPA) Emergency Response and Community Right-to-Know Act of 1986 ensures the availability of MSDSs to emergency response personnel, such as fire departments, first aid crews, and hospital emergency room staff.

The MSDS contains a wealth of information that may be understood with a minimum of training. Below is a brief explanation of the format and information found in a properly prepared MSDS.

### Section 1

This section identifies the material by product or trade name and chemical name. It is the product or trade name that is usually found on the container labels, although the chemical name is also required by some states. Section I also contains the manufacturer s name, address, and telephone number.

### Section 2

Section 2 provides physical data about the product that can be utilized for proper identification. Included are specifics such as color, odor, specific gravity (weight), vapor pressure, and boiling point.

### Section 3

This section lists the chemical ingredients of the material, if they are known or suspected to be hazardous. Hazardous materials that are not carcinogens must be reported if they represent 1 percent or more of the product. Carcinogens must be reported and identified as such if their levels are 0.1 percent or higher. Also included in Section 3 are Threshold Limit Values (TLVs) and the OSHA Permissible Exposure Limit (PEL).

### Section 4

Section 4 includes fire and explosion hazard data. This information is especially useful when devising both in-house and community contingency plans. Plant first responders, local fire departments, and hazmat teams need unlimited access to this information.

## Section 5

Section 5 contains health hazard data. It describes any acute (short-term exposure) and/or chronic (long-term exposure) effects on the body. These include routes of exposure (inhalation, dermal contact, ingestion) and the bodily organs affected, as well as the signs and symptoms of overexposure. First aid procedures are also be found in this section. (NOTE: First aid measures recommended in MSDSs are not always correct and should be confirmed.)

## Section 6

This section contains information on the reactivity of the product. It lists other chemicals that, when mixed with the product, will result in a chemical reaction. If a product is water reactive, it will be noted.

Also included in Section 6 is information on hazardous decomposition products, such as carbon monoxide and other hazardous gases, that are formed and emitted during chemical reactions or fires. It is imperative that this section be carefully noted by both in-house and local firefighters.

## Section 7

Section 7 lists the procedures that should be used if the product spills or leaks, including waste disposal methods.

## Section 8

Section 8 contains information regarding the proper personal protective equipment (PPE) necessary to handle the product in a manner that will minimize exposure. Ventilation practices are also listed in this section.

## Summary

A Material Safety Data Sheet can aid in making the right decisions on health and safety issues in a plant or in a community. It must be noted, however, that it is but one of many references that should be used to make final determinations. MSDSs are offered by manufacturers for identification and verification and are not the last word on safety and health practices.

# 1. MATERIAL SAFETY DATA SHEET

| | |
|---|---|
| PRODUCT NAME: | CAS # |
| CHEMICAL NATURE: | |
| % ACTIVITY: | |

## 2. PHYSICAL DATA

| | | | |
|---|---|---|---|
| BOILING POINT, 760 MM HG | | FREEZE POINT | |
| SPECIFIC GRAVITY | | VAPOR PRESSURE AT 20 C | |
| VAPOR DENSITY | | SOLUBILITY IN H20 | |
| PER CENT VOLATILES BY WEIGHT | | IONIC NATURE | |
| APPEARANCE AND ODOR | | | |

## 3. CHEMICAL INGREDIENTS

| MATERIAL | % | TLV (Units) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

## 4. FIRE AND EXPLOSION HAZARD DATA

| | | | | | |
|---|---|---|---|---|---|
| FLASH POINT (test methods) | | AUTOIGNITION TEMPERATURE | | | |
| FLAMMABLE LIMITS IN AIR, % by volume | | Lower | | Upper | |
| EXTINGUISHING MEDIA | | | | | |
| SPECIAL FIRE FIGHTING PROCEDURES | | | | | |
| UNUSUAL FIRE AND EXPLOSION HAZARDS | | | | | |

*SAMPLE MATERIAL SAFETY DATA SHEET*

## 5. HEALTH HAZARD DATA

| |
|---|
| TRESHOLD LIMIT VALUE |
| EFFECTS OF EXPOSURE |
| EMERGENCY AND FIRST AID PROCEDURES |

## 6. REACTIVE DATA

| | | | |
|---|---|---|---|
| STABILITY | | CONDITIONS TO AVOID | |
| UNSTABLE | STABLE | | |
| | | | |
| COMPATIBILITY | | | |
| HAZARDOUS RECOMPOSITION PRODUCTS | | | |
| HAZARDOUS POLYMERIZATION | | CONDITIONS TO AVOID | |

## 7. SPILL OR LEAK PROCEDURES

| | |
|---|---|
| STEPS TO BE TAKEN OR MATERIAL IS RELEASED OR SPILLED | |
| WASTE DISPOSAL METHOD | |

## 8. SPECIAL PROTECTION INFORMATION

| | | | | |
|---|---|---|---|---|
| RESPIRATORY PROTECTION | | | | |
| VENTILATION | LOCAL EXHAUST | | SPECIAL | |
| | MECHANICAL | | OTHER | |
| PROTECTIVE GLOVES | | | EYE PROTECTION | |
| OTHER PROTECTIVE EQUIPMENT | | | | |

## 9. SPECIAL PRECAUTIONS

| | |
|---|---|
| PRECAUTIONARY LABELING | |
| OTHER HANDLING AND STORAGE CONDITIONS | |

*SAMPLE MATERIAL SAFETY DATA SHEET*

# Appendix B

## Types of Respiratory Protection

## Appendix B
## Types of Respiratory Protection

| Type of Respirator | Advantages | Disadvantages |
|---|---|---|
| **Air Purifying** | | |
| *Air-Purifying Respirator* (including powered sea level) [PAPRs]) | Enhanced mobility | Cannot be used in IDLH or oxygen-deficient atmospheres (less than 19.5 percent oxygen at air-purifying respirators |
| | Lighter in weight than an SCBA; generally weighs 2 pounds or less (except for PAPRs) | Limited duration of protection; may be hard to gauge safe operating time in field conditions |
| | | Only protects against specific chemicals, and up to specific concentrations |
| | | Use requires monitoring of contaminant and oxygen levels |
| | | Can only be used: (1) against gas and vapor contaminants with adequate warning properties; or (2) for specific gases or vapors provided that the service is known and a safety factor is applied, or if the unit has an ESLI (end-of-service-life-indicator) |
| **Atmosphere-Supplying** | | |
| *Self-Contained Breathing Apparatus (SCBA)* | Provides the highest available level of protection against airborne contaminants and oxygen deficiency | Bulky, heavy (up to 35 pounds) |
| | | Finite air supply limits work duration |
| | Provides the highest available level of protection under strenuous work conditions | May impair movement in confined spaces |

## Appendix B (continued)

| Type of Respirator | Advantages | Disadvantages |
|---|---|---|
| *Positive Pressure Supplied-Air Respirator (SAR)* | Enables longer work periods than an SCBA | Not approved for use in IDLH or oxygen-deficient atmospheres (less 19.5 percent oxygen at sea level) unless equipped with an emergency egress unit, such as an escape-only SCBA, that can provide immediate emergency respiratory protection in case of air line failure |
| (also called air line respirator) | Less bulky and heavy than an SCBA; SAR equipment weigh less than 5 pounds (or around 15 pounds, if escape SCBA protection is included) | Impairs mobility |
| | Protects against most airborne contaminants | Mine Safety and Health Administration/ NIOSH certification limits hose length to 300 feet |
| | | As the length of the hose is increased, the minimum approved airflow may not be delivered at the faceplate |
| | | Air line is vulnerable to damage, chemical contamination, and degradation. Decontamination of hoses may be difficult |
| | | Worker must retrace steps to leave work area |
| | | Requires supervision/monitoring of the air supply line |

# Appendix C

## Levels of Protection

## Appendix C
## Levels of Protection[1]

| Level of Protection | Equipment | Protection Provided | Should be used when: | Limiting Criteria |
|---|---|---|---|---|
| **A** | **Recommended:**<br>Pressure-demand, full facepiece SCBA or pressure-demand, supplied-air respirator with escape SCBA<br><br>Fully-encapsulated, chemical-resistant suit<br><br>Inner chemical-resistant gloves<br><br>Chemical-resistant safety boots/shoes<br><br>Two-way radio communication | The highest available level of respiratory, skin, and eye protection | The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory systems based on:<br><br>-measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or<br><br>-site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin | Fully-encapsulated suit; material must be compatible with the substances involved |
| | **Optional:**<br>Cooling unit<br><br>Coveralls<br><br>Long cotton underwear<br><br>Hard hat<br><br>Disposable gloves and boot covers | | Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible<br><br>Operations must be conducted in confined, poorly ventilated areas until the absence of conditions requiring Level A protection is determined | |

[1] Reprinted from NIOSH/OSHA/USCG/EPA 1985. *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.* Washington, D.C.: Department of Health and Human Services.

## Appendix C (continued)
## Levels of Protection

| Level of Protection | Equipment | Protection Provided | Should be used when: | Limiting Criteria |
|---|---|---|---|---|
| **B** | **Recommended:**<br>Pressure-demand, full-facepiece SCBA or pressure-demand, supplied-air respirator with escape SCBA<br><br>Chemical-resistant clothing (overalls and long sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit)<br><br>Inner and outer chemical-resistant gloves<br><br>Chemical-resistant safety boots/shoes<br><br>Hard hat<br><br>Two-way radio communications<br><br>**Optional:**<br>Coveralls<br><br>Disposable boot covers<br><br>Face shield<br><br>Long cotton underwear | The same level of respiratory protection, but less skin protection than Level A<br><br>It is the minimum level recommended for initial site entries until the hazards have been further identified | The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves:<br><br>-atmosphere with IDLH concentrations of specific substances that do not represent a severe skin hazard; or<br><br>-atmosphere containing less than 19.5 percent oxygen<br><br>Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through intact skin | Use only when the vapor or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through intact skin<br><br>Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin |

## Appendix C (continued)
## Levels of Protection

| Level of Protection | Equipment | Protection Provided | Should be used when: | Limiting Criteria |
|---|---|---|---|---|
| **C** | **Recommended:**<br>Full-facepiece, air-purifying, canister-equipped respirator<br><br>Chemical-resistant clothing (overalls and long sleeved jacket: hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit)<br><br>Hard hat<br><br>**Optional:**<br>Gloves<br><br>Escape mask<br><br>Face shield | No respiratory protection; minimal skin protection | The atmosphere contains no known hazard<br><br>Work functions preclude, splashes immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals | This level should not be worn in the Exclusion Zone<br><br>The atmosphere must contain at least 19.5 percent oxygen |
| **D** | **Recommended:**<br>Coveralls<br><br>Safety boots/shoes<br><br>Safety glasses or chemical splash goggles<br><br>Hard hat<br><br>**Optional:**<br>Gloves<br><br>Escape mask<br><br>Face Shield | No respiratory protection; minimal skin protection | The atmosphere contains no known hazard<br><br>Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals | This level should not be worn in the Exclusion Zone<br><br>The atmosphere must contain at least 19.5 percent oxygen |

## Comments

The Agency for Toxic Substances and Disease Registry would greatly appreciate your comments and suggestions for improving future editions of this guidance document. Comments may be addressed to:

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# *Managing Hazardous Materials Incidents*

## Volume III
***(revised)***

## Medical Management Guidelines for Acute Chemical Exposures


**U.S. Department Of Health And Human Services**
**Public Health Service**
**Agency for Toxic Substances and Disease Registry**

The state of knowledge regarding the treatment of patients potentially exposed to hazardous substances in the environment is constantly evolving and is often uncertain. In this document, the Agency for Toxic Substances and Disease Registry (ATSDR) has made diligent effort to ensure the accuracy and currency of the ‘information presented but makes no claim that the document comprehensively addresses all possible situations related to this topic. This document is intended as an additional resource for physicians and other health professionals in assessing the condition and managing the treatment of patients potentially exposed to hazardous substances. It is not, however, a substitute for the professional judgment of a health care provider and must be interpreted in light of specific information regarding the patient available to such a professional and in conjunction with other sources of authority.

**Agency for Toxic Substances and Disease Registry**
**2000**

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# Acronyms and Abbreviations

| | |
|---|---|
| AAPCC | American Association of Poison Control Centers |
| ABG | arterial blood gases |
| ABS | acrylonitrile/butadiene/styrene |
| ACGIH | American Conference of Governmental Industrial Hygienists |
| AIHA | American Industrial Hygiene Association |
| ALS | advanced life support |
| AOEC | Association of Occupational and Environmental Clinics |
| ARDS | acute respiratory distress syndrome |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BAL | British anti-Lewisite (dimercaprol) |
| BUN | blood urea nitrogen |
| C | Celsius |
| CDC | Centers for Disease Control and Prevention |
| CAS | Chemical Abstract Service |
| CBC | complete blood count |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CNS | central nervous system |
| CPC | chemical protective clothing |
| CPK | creatine phosphokinase |
| DC | direct current |
| DHHS | Department of Health and Human Services |
| dL | deciliter |
| DMSA | 2,3-demercaptosuccinic acid |
| DNA | deoxyribonucleic acid |
| DOT | Department of Transportation |
| ECG | electrocardiogram |
| ED | emergency department |
| EEG | electroencephalogram |
| EMS | emergency medical services |
| EMSA | Emergency Medical Services Authority |
| EPA | Environmental Protection Agency |
| ERPG | Emergency Response Planning Guideline |
| F | Fahrenheit |
| g | gram |
| GABA | gamma aminobutyric acid |
| GAO | General Accounting Office |
| GI | gastrointestinal |
| G6PD | glucose-6-phosphate dehydrogenase |
| HAZMAT | hazardous material |
| HCl | hydrochloric acid |
| HClO | hypochlorous acid |
| HSDB | Hazardous Substances Data Bank |

| | |
|---|---|
| IARC | International Agency for Research on Cancer |
| IDLH | immediately dangerous to life and health |
| IRIS | Integrated Risk Information System |
| i.v. | intravenous |
| kg | kilogram |
| L | liter |
| m | meter |
| mEq | milliequivalent |
| mg | milligram |
| mL | milliliter |
| mm Hg | millimeters of mercury |
| $m^3$ | cubic meters |
| MSDS | Material Safety Data Sheet |
| MSHA | Mine Safety and Health Administration |
| MTBE | methyl-*t*-butyl ether |
| MW | molecular weight |
| NAC | N-acetylcysteine |
| NFPA | National Fire Protection Association |
| NIOSH | National Institute for Occupational Safety and Health |
| NO | nitric oxide |
| NPIRS | National Pesticides Information Retrieval System |
| NTP | National Toxicology Program |
| OSHA | Occupational Safety and Health Administration |
| PAM | pralidoxime chloride |
| PEG | polyethylene glycol |
| PEL | permissible exposure limit |
| PhAC | S-phenyl-N-acetyl cysteine |
| $Po_2$ | partial pressure of oxygen |
| ppm | parts per million |
| PVC | polyvinyl chloride |
| RADS | reactive airways dysfunction syndrome |
| RBC | red blood cel1 |
| SARA | Superfund Amendments and Reauthorization Act |
| SCBA | self-contained breathing apparatus |
| STEL | short-term exposure limit |
| TBA | *t*-butyl alcohol |
| TOCP | tri-*o*-cresyl phosphate |
| TSCA | Toxic Substances Control Act |
| TWA | time-weighted average |
| TERIS | Teratogen Information Service |
| UN | United Nations |
| UV | ultraviolet |
| WHO | World Health Organization |

# Preface

The Agency for Toxic Substances and Disease Registry (ATSDR) is an agency of the Public Health Service in the U.S. Department of Health and Human Services (DHHS). ATSDR was created by the U.S. Congress through the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The Agency's responsibilities were markedly increased through the Superfund Amendments and Reauthorization Act of 1986 (SARA). The mission of ATSDR is to prevent or mitigate adverse human health effects and diminished quality of life resulting form exposure to hazardous substances in the environment. In pursuit of this mission, ATSDR provides educational and referral resources to health care providers who are responsible for chemically exposed patients.

The *Medical Management Guidelines for Acute Chemical Exposures (Guidelines)* is designed to assist emergency department physicians. It is the third volume in a 3-volume series provided by ATSDR. The Guidelines contain 40 chemical-specific protocols that provide recommendations for the on-scene (prehospital) and hospital (ED) medical management of patients exposed during a hazardous materials (HAZMAT) incident. Other rescue personnel, such as first responders, emergency medical technicians, and public health officials, will also find the information useful, but because of the focus of the protocols, these professions are encouraged to rely on other sources and training in their primary field for more definitive and complete guidance.

Each chemical protocol is divided into five sections.

(1) **Description:** Contains synonyms, appearance, routes of exposure; potential for secondary contamination, sources/uses, physical properties, and exposure standards.

(2) **Health Effects:** Contains organ systems affected by acute exposure, potential sequelae, and effects of chronic exposure.

(3) **Prehospital Management:** Contains personal protection, decontamination, support, triage, and transportation. Organized by Hot Zone, Decontamination Zone, and Support Zone.

(4) **Emergency Department Management:** Contains specific medical procedures to treat the exposed patient, and patient disposition. Organized by Decontamination Area and Critical Care Area.

(5) **Patient Information Sheet:** Contains information on exposure, potential effects, and follow-up instructions for the victims of a HAZMAT incident.

The *Introduction* to this volume provides important background information and a brief overview of the activities at a HAZMAT incident. For more information on managing HAZMAT activities, consult Volumes I and II, *Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients,* and *Hospital Emergency Department: A Planning Guide for the Management of Contaminated Patients,* respectively. The *Introduction* also describes the use, rationale, and limitations of the data contained in each section of a chemical protocol. It is written in the format of an individual protocol. The *Prehospital Management* and *Emergency Department Management* sections of the *Introduction* begin with the recommendations form the *Unidentified Chemical* protocol. The recommendations are followed by the rationale for the procedures suggested. The reader is urged to complete the *Introduction* before attempting to use the individual protocols.

Appendices I through IV contain resources for the emergency department physician seeking consultation in treating chemically exposed patients: AAPCC-Certified Regional Poison Control Centers; Association of Occupational and Environmental Health Clinics; State Health Officials; and private, university, and government consultants are listed. In addition, the *Guidelines* contains a glossary of chemical and medical terminology.

# Acknowledgments

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This project was directed by Scott V. Wright, ATSDR. For the 2000 version, Lisa Ingerman, Ph.D., of Syracuse Research Corporation (SRC) was the project manager, and A. Rosa MacDonald, Ph.D., Fernando Llados, Ph.D., and Susan Little, Ph.D., of SRC were contributing scientists (under ATSDR contract No. 205-1999-00024).

The major contributors to the original (1992) *Medical Management Guidelines for Acute Chemical Exposures* were Jonathan Borak, MD, Kent R. Olson, MD, and Virginia Sublet, PhD.

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# Introduction

This *Introduction*, which is in the same format as the individual protocols, describes the use and limitations of the information presented. The *Prehospital and Emergency Department* sections incorporate the *Unidentified Chemical* protocol as an example. The *Introduction* is key to the appropriate use of the protocols. Even trained and experienced responders are urged to read it before using the individual protocols in an emergency situation.

Use of trade names is for identification only and does not imply endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

# *General Information Section*
# Chemical Name (Chemical Formula)
# CAS Number; UN Number

Common synonyms

- **Potential for secondary contamination**
- **Common form and important characteristics such as odor and flammability**
- **Routes of exposure and potential for absorption**

## Secondary Contamination

Primary contamination refers to direct contact of the victim with the hazardous material. Secondary contamination refers to the transfer of material from the victim to personnel or equipment. The potential for secondary contamination has implications for decontamination and triage of victims and for the protection of rescue and health care personnel. Immediate victim decontamination is recommended for materials that pose risks of secondary contamination; this eliminates both the potential for rescuer contamination and further exposure to the victim.

A substance poses a risk of secondary contamination if it is both toxic and likely to be carried on the clothing, skin, or hair of victims in sufficient quantities to threaten other personnel. Substances that present the most serious risks of secondary contamination include the following:

- highly toxic liquids and solids or finely divided solids (e.g., organophosphate pesticides)
- radioactive liquids and dusts
- certain biologic agents (e.g., harmful viruses or bacteria)

Every effort must be made to decontaminate contaminated victims before they are transported to a medical care facility.

Examples of substances with little or no risk of secondary contamination include the following:

- gases (e.g., carbon monoxide, amine)
- vapors (unless they condense to a liquid state on clothing or skin)
- substances with no serious toxicity or skin absorption (e.g., propylene glycol, motor oil)

Note that although several of the substances listed above are highly toxic (e.g., arsine, carbon monoxide), they do not pose

risks of secondary contamination because these chemicals will not contaminate the victim; therefore, they cannot secondarily contaminate rescuers.

Secondary contamination also may be a risk in cases of ingestion. Ingested materials may react with stomach acid to produce noxious gases, which can pose risks to both the victim and rescuers. Vomitus may off-gas the hazardous material or a reaction product. Toxic vomitus should be quickly isolated in closed containers.

Previously published documents on hazardous materials have recommended zipping patients into body bags to minimize the transfer of chemical from patient to rescuer. This technique is not completely effective for preventing rescuer exposure, and it may pose a significant risk of increased dermal absorption to victims. Body bags are not recommended as an alternative to thorough decontamination.

## Description

This section summarizes the color, odor, and physical state (solid, liquid, or gas) of the chemical at room temperature. Methods of shipment or storage and the physical hazards associated with the chemical are also described.

## Routes of Exposure

The most likely routes of exposure--inhalation, direct contact with the skin or eyes, and ingestion-are described. For each route of exposure, the risk of injury depends on the toxicity of the chemical involved, the concentration of the material, and the duration of con tact.

### *Inhalation*

Inhalation is the most common route of exposure to gases and vapors. Liquids and solids may also be inhaled when they are finely divided mists, aerosols, fumes, or dusts. Highly water-soluble gases and vapors and larger mist or dust particles (greater than 10 microns in diameter) generally are deposited in the upper airways. Less soluble gases and vapors and smaller particles can be inhaled more deeply into the respiratory tract. Usually, highly water-soluble materials rapidly produce symptoms of upper-airway irritation, whereas less soluble materials may produce delayed symptoms in the lower airways. Inhaled substances may be absorbed into systemic circulation, causing toxicity to various organ systems. When available, information is provided on odor threshold, warning properties, and symptoms to be expected at specific exposure levels.

### *Skin/Eye Contact*

Skin and eye contact can occur by exposure to solids, liquids, or gases. Corrosive agents cause direct damage to tissues by various

mechanisms including low or high pH, chemical reaction with surface tissue, removal of normal skin fats (defatting), or removal of moisture (desiccant effect). Some chemicals absorbed through the skin and eyes can produce systemic toxicity. Absorption, and therefore toxicity, is more likely to occur when the normal skin barrier is disrupted (e.g., chemical bum, cut, or abrasion) or when the chemical is highly fat-soluble (e.g., organophosphate and organochlorine pesticides).

*Ingestion*

Ingestion is not a common route of exposure in most hazardous materials (HAZMAT) incidents, although it is common in suicide attempts. Ingestion of corrosive agents can cause severe burns to the mouth, throat, esophagus, and stomach. Ingested chemicals may also be aspirated into the lungs, especially after vomiting, causing chemical pneumonitis. Ingested chemicals may react with stomach acid, creating products that are toxic to the patient, and potentially, the health care provider (e.g., hydrogen cyanide from ingested cyanide salts).

**Sources/Uses**

This section describes the chemical's most common uses and the methods of production.

**Standards and Guidelines**

Government agencies and professional organizations have established standards and guidelines for hazardous chemical exposures. The standards and guidelines address both acute and chronic exposures.

The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) is a regulatory limit established to avoid adverse health effects from exposure. PELs are time-weighted-average (TWA) air concentrations. In most cases, a healthy, working adult can be exposed to a chemical at the PEL for an g-hour workday and a 40-hour workweek and suffer no adverse health effects. If the measured air concentration at a HAZMAT incident is less than the PEL and the exposure is short-term, persons at the scene are probably not at serious risk. The OSHA "skin" designation indicates the likelihood of dermal absorption.

The OSHA ceiling is an instantaneous concentration that must not be exceeded any time. If instantaneous monitoring is not feasible, the ceiling is normally assessed as a 15minute TWA concentration.

The OSHA short-term exposure limit (STEL) is a 15-minute (unless otherwise noted) TWA concentration that should not be

exceeded at any time, even if the 8-hour TWA concentration is below the PEL.

The National Institute for Occupational Safety and Health (NIOSH) recommends workplace exposure guidelines. The NIOSH immediately dangerous to life or health (IDLH) level represents the maximum chemical concentration from which one could escape within 30 minutes without a respirator and without experiencing any escape-impairing (e.g., severe eye irritation) or irreversible health effects.

The American Industrial Hygiene Association (AIHA) Emergency Response Planning Guidelines (ERPG) state concentrations at which one might reasonably anticipate observing adverse effects from exposure to specific substances. Unlike occupational expo sure standards, ERPG levels are applicable to the general public, including children and the elderly. The three ERPG levels vary with the health effects expected with exposure (transient symptoms, ability impairment, and life-threatening) and apply to practically all persons. The table in the Properties section includes only ERPG-2-the exposure level that could impair a person's ability to take protective action.

ERPG levels are defined as follows:

ERPG-1 is the maximum airborne concentration below which it is believed that nearly all persons could be exposed for up to 1 hour without experiencing symptoms other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.

ERPG-2 is the maximum airborne concentration below which it is believed that nearly all persons could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

## Physical Properties

**Description:** Physical state and useful characteristics of the chemical at room temperature are presented.

**Warning properties:** Odor and irritation are the primary determinants of exposure awareness. When available, an objective description of odor (e.g., garlic-like) and the lowest air

concentration that can be detected (i.e., odor threshold) is provided. For chemicals with an odor threshold below the toxic air concentration, odor may provide an adequate warning of dangerous exposure conditions. However, a chemical is considered to have inadequate warning properties if it has no detectable odor at toxic air concentrations, has an odor that is not reliably detected because of olfactory fatigue, or does not cause irritation.

**Molecular weight** (MW) is the sum of the weights of the atoms in a molecule. Molecular weight is provided in daltons, a unit that is based on the mass of oxygen- 16. Molecular weight can be used to convert measurements of air concentrations of chemicals from parts per million (ppm) to milligrams per cubic meter (mg/m3) using the following equation:

$mg/m^3 = (ppm \times M W) / 22.4 L/mole$

(1 mole of gas occupies 22.4 L at standard temperature and pressure).

**Boiling point** of a liquid is the temperature at which its vapor pressure is equal to the atmospheric pressure. A boiling point at or below room temperature means that the chemical is in the gaseous state at room temperature.

**Freezing point** is the temperature at which a chemical's solid phase is in equilibrium with the liquid phase. Freezing point and melting point are equal in numeric value. The term"freezing point" refers to the temperature at which a liquid forms a solid; "melting point" refers to the temperature at which a solid forms a liquid.

**Specific gravity** is the ratio of the density of a liquid to the density of a reference material (usually water). A specific gravity less than 1 indicates that the substance will float on water; a specific gravity greater than 1 indicates that the substance will sink in water.

**Vapor pressure** is the pressure (expressed in millimeters of mercury [mm Hg] of a vapor in equilibrium with its liquid or solid form at a given temperature. The higher the vapor pressure, the greater the amount of chemical existing in the vapor phase. A vapor pressure greater than 760 mm Hg at room temperature indicates that the chemical exists as a gas.

**Gas density** is the ratio of the density (weight per volume) of a substance (at a given temperature) to the density of air (at that temperature). A gas density greater than 1 indicates that the vapor or gas is heavier than air. A gas heavier than air may collect in

low-lying areas where it can displace air, creating an oxygen-deficient atmosphere.

**Water solubility** indicates the degree to which a substance dissolves in water at a specific temperature. Water solubility is measured in weight of substance per volume of water (e.g., g/100 ml or %). Water solubility may indicate the effectiveness of water in decontamination. A substance that is water soluble is likely to be removed from the skin and hair with a plain water wash. Substances that are poorly water soluble may require the use of soap.

**Flammability** is the ease with which a material will ignite. Flammable chemicals have flash points below l00 °F; combustible chemicals have flashpoints between 100 °F and 200°F; and nonflammable chemicals have flashpoints above 200 °F.

**Flammable range** (lower explosive limit to upper explosive limit) is expressed as the percentage of gas or vapor dispersed in air that will bum when an ignition source is present. The temperature, the flammable range, and the potential for a vapor or gas to travel to an ignition source and flash back may affect rescue activities. The flammable range may indicate the need for special protective clothing. Most chemical-resistant protective clothing is neither heat- nor flame-resistant and may melt if a fire occurs.

## Incompatibilities

HAZMAT incidents commonly involve more than one chemical. Incompatibility and reactivity information, primarily from the NIOSH Pocket Guide to Chemical Hazards, is included in this section.

## *Health Effects Section*

- **Common symptoms**
- **Systemic effects and mechanism of action**

Health risk depends on the intrinsic toxic potential of the chemical, its concentration, and the duration of exposure. Highly toxic chemicals may pose a risk of illness even if the exposure duration is brief or the concentration of the substance is low. Even mildly toxic substances, however, can be hazardous if the exposure is prolonged or the concentration is high.

### Acute Exposure

When suspected or known, the mechanism of action is discussed.

Acute exposure is defined as chemical exposure of less than 14 days duration. Most HAZMAT incidents involve acute exposures that last only minutes, but the chemical concentration may be extremely high. Although HAZMAT incident exposures are likely to be short, risks of adverse health effects still exist. The onset of health effects caused by acute exposure can be immediate or delayed.

Organ systems or metabolic processes that are adversely affected by the chemical are discussed in the following sections. The organ system or metabolic process mentioned first in each chemical protocol is the most severely affected, those not affected by the chemical are not addressed.

*Cardiovascular*

Many chemicals have direct depressant or stimulatory effects on cardiac function. Hypotension and dysrhythmias may be aggravated by hypoxia from respiratory depression or pulmonary aspiration of gastric contents. Hypotension may also occur because of volume depletion from excessive vomiting, diarrhea, or severe chemical bums.

Certain solvents (e.g., chlorinated hydrocarbons, freons, aromatic hydrocarbons) may lower the myocardial threshold to the dysrhythmogenic effects of catecholamines. For several hours after solvent exposure, a victim may be susceptible to ventricular dysrhythmias (e.g., premature ventricular contractions, ventricular tachycardia, or ventricular fibrillation) especially from administered sympathomimetic drugs such as bronchodilators or dopamine or the increased quantity of endogenous epinephrine produced during intense physical activity.

*CNS*

Central nervous system (CNS) depressants (e.g., hydrocarbon solvents) cause a generalized decrease in brain activity. Headache, dizziness, confusion, lethargy, stupor, or coma may result. Severe depression of the brain stem can cause respiratory arrest and cardiovascular collapse. Some chemical depressants have early stimulatory effects, producing euphoria and giddiness similar to ethanol.

CNS stimulants (e.g., organophosphate insecticides) can cause agitation, anxiety, delirium, and seizures. Excessive muscular activity associated with seizures can cause hyperthermia.

*Dermal*

Dermal contact with chemicals can produce local injury; if absorbed, chemicals can also produce systemic effects. Local injuries (e.g., burns from mineral acids) usually are immediately obvious. However, a few chemicals (e.g., alkaline corrosives, hydrofluoric acid) cause a progressive penetrating injury that may not be apparent for hours.

The skin generally provides a relatively impermeable protective barrier. Many chemicals disrupt the skin's integrity by removing fats, producing chemical burns, or destroying cells. Physical injury such as thermal bums or traumatic events may also result in loss of the skin's barrier effect. Disruption of the normal protective barrier allows easier entry of chemicals into systemic circulation. Systemic illness can also occur without skin damage because many fat-soluble chemicals (e.g., some organophosphate insecticides) rapidly penetrate intact skin.

*Electrolyte*

Some chemicals can produce effects on serum electrolytes (e.g., potassium, calcium, sodium) and total anion gap. Electrolyte imbalance can cause muscle weakness and cardiac dysrhythmias.

*Gastrointestinal*

Nausea, vomiting, abdominal pain, and diarrhea are common symptoms after chemical exposure and may be due to direct gastrointestinal irritation or to systemic effects. Ingestion of some chemicals can also cause severe corrosive injury to the mouth, throat, esophagus, and stomach, with bleeding, perforation, scarring, or stricture formation as potential sequelae.

*Hematologic*

Components of the blood and blood-forming organs can be damaged by many chemicals (e.g., arsine, benzene). Most hematologic changes (e.g., hemolysis, methemoglobinemia, bone marrow suppression, and anemia) can be detected by blood tests or simply by the color or appearance of the blood

*Hepatic* Some chemical exposures result in acute injury to the liver, which typically does not manifest for 2 to 3 days after exposure. At that time, laboratory tests will show abnormal liver function (e.g., elevated bilirubin or aminotransferase levels or increased prothrombin time). Toxic hepatitis may progress to liver failure and death.

*Immunologic* Immunologic effects may include induced sensitivity and allergy.

*Metabolic* Metabolic acidosis is the most common adverse metabolic effect that occurs after chemical exposure. Acidosis results from an accumulation of acid anions such as formic, lactic, or oxalic acid.

*Musculoskeletal* Musculoskeletal damage due to chemical exposure is unusual. Some effects are arthritis and hardening, destruction, or cancer of the bone.

*Ocular* Most serious ocular injuries result from direct eye contact with corrosive liquids or solids. High concentrations of or prolonged exposures to gases or vapors may also injure the eye. Severe eye exposure carries a risk of blindness or other visual impairment and demands immediate evaluation by an ophthalmologist.

Most patients who have eye injuries involving the conjunctival or cornea1 surfaces experience pain and irritation, excessive lacrimation, and possibly crusting and swelling of the eyelids. Generally, corneal damage causes intense pain and the sensation of a foreign body in the eye.

*Peripheral Neurologic* Peripheral nervous system effects can include changes in sensation, reduced reflexes, and impaired motor function. Effects are pronounced in the largest muscle groups such as those in the lower limbs.

*Renal* Some chemicals injure the kidneys directly. In addition, any poisoning causing massive muscle destruction can lead to kidney injury from excessive myoglobin in the kidney tubules.

*Respiratory* Inhalation of a chemical irritant (e.g., ammonia, chlorine) usually causes rapid onset of burning and irritation of the nose, throat, and upper respiratory tract. Painful coughing, wheezing, and stridor may develop. If the exposure is massive, death may rapidly ensue from upper airway obstruction, massive alveolar destruction, or asphyxiation. Chest radiography may indicate pulmonary edema when damaged lung cells allow fluid to leak into the alveoli (referred to as noncardiogenic pulmonary edema because the fluid

accumulation is not caused by left ventricular failure, which occurs in cardiogenic pulmonary edema).

The onset and location of respiratory symptoms is partially related to the water solubility of the inhaled chemical. Highly water-soluble gases, such as ammonia, cause rapid onset of symptoms (burning nose and throat, painful cough, stridor, wheezing) as the gases dissolve in the mucous membranes of the upper respiratory tract. However, less soluble gases such as phosgene are breathed deeply into the lower airways and typically cause only mild or no early symptoms; noncardiogenic pulmonary edema may develop after 12 to 36 hours.

Injury to the respiratory tract also can occur after ingestion of a chemical substance. The unconscious or convulsing patient may vomit and then, because of depressed airway protective reflexes, may aspirate gastric contents into the lungs. Pulmonary aspiration of an ingested hydrocarbon can cause severe pneumonitis. Hydrocarbons irritate the lung tissue and interfere with surface tension in the alveoli, disrupting gas exchange. Pulmonary aspiration can sometimes be prevented by inserting a cuffed endotracheal tube into the patient's airway or by placing the patient in a head-down, left-side position and using suction immediately if vomiting occurs.

*Potential Sequelae*

Known or suspected sequelae and the prognosis for recovery after an acute exposure are described in this section. Signs and symptoms expected at various stages of recovery and the potential for permanent deficits are presented.

## Chronic Exposure

Repeated, low-level exposures, typically over a long period of time, may produce health effects that differ in type or degree from effects of acute exposure. Most information about chronic toxicity is from epidemiologic studies and case reports of workplace exposures. Because HAZMAT incidents are unlikely to involve repeated or long-term exposures, chronic health effects are outlined only briefly.

Some major concerns of patients who have experienced an acute chemical exposure are the risks of cancer, reproductive effects, or impaired fetal development. No data exist on these outcomes from acute exposure to most chemicals. However, to guide the clinician who must address these patient concerns, we have included carcinogenic, reproductive, and developmental effects that have resulted from chronic exposure to the chemical. It is not known whether the data from chronic exposures are applicable to victims who are acutely exposed in a HAZMAT incident.

*Carcinogenicity*

The cancer information included in this section is derived from assessments made by the Department of Health and Human Services (DHHS), the International Association for Research on Cancer (IARC), or the Environmental Protection Agency (EPA). These organizations develop ratings of chemicals that indicate the cancer-producing ability of the chemicals. The information included was based on the following hierarchy: DHHS is offered if available, then IARC, then EPA. Failure of these organizations to evaluate a chemical does not necessarily mean that the chemical does not cause cancer.

*Reproductive and Developmental Effects*

Information about reproductive and developmental effects was obtained primarily from three data files that are included in TOMES Plus, a proprietary database of Micromedex, Inc., Denver, CO. These data files are Reprotext, edited by Betty J. Dabney, PhD; the Teratogen Information System (TERIS), developed by the University of Washington; and Shepard's Catalog of Teratogenic Agents, written by Thomas H. Shepard, MD. An additional source of information was Reproductive and Developmental Toxicants, a 1991 report published by the U.S. General Accounting Office (GAO Report no. GAOLPEMD-92-3) that lists 30 chemicals of concern because of widely acknowledged reproductive and developmental consequences. The 30 chemicals are alcohol, arsenic, cadmium, carbon disulfide, carbon monoxide, chlordecone, chloroprene, DDT, DBCP, DES, ethylene dibromide, EGEE, EGME, ethylene oxide, gossypol, hexachlorobenzene, lead, lithium, mercury, nicotine, PBBs, PCBs, 2,4,5-T, TCDD, tobacco smoke, toluene, vinyl chloride, vitamin A, and warfarin.

The topic of reproductive hazards is controversial and emotionally charged. Potentially high risk to the fetus may warrant considering termination of the pregnancy. Most clinicians are not adequately prepared to help the patient make this decision. Expert assistance may be available from regional poison control centers, regional reproductive risk/teratogen information centers, or the MotherRisk Program. For more information, see Appendices I and III.

## *Prehospital Management Section*

The Prehospital Management section describes the activities that typically occur in the three concentric areas surrounding a HAZMAT incident (Figures 1 and 2), particularly those activities that relate to Emergency Medical Services (EMS) personnel. The Hot Zone (or Exclusion Area) is the area surrounding the chemical release; it is assumed to pose an immediate health risk. 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. The Support Zone (or Cold Zone) is the outermost ring where no exposure or risk is expected. The incident commander, medical personnel, and other support persons and equipment operate in the Support Zone. The information provided in the chemical protocols is an attempt to offer an accurate and practical approach to the management of hazardous materials emergencies. 'The user of the protocols should be aware that large data gaps exist in the scientific literature.

**Goals of the EMS HAZMAT Responder**

- Protect yourself. Approach the Scene cautiously, arriving upwind. Maintain a safe distance and inspect the scene from a nearby elevated area such as a hill. Respect the established exclusion zones and resist the temptation to rush in to attempt a rescue. If a command post has been established, report to the incident commander.

- Identify the chemical. Be familiar with the Department of Transportation (DOT) placard system, the National Fire Protection Association (NFPA) hazard labeling system, Material Safety Data Sheets (MSDS), and shipping papers.

- Consult the appropriate protocol and local sources to obtain information about the chemical, its health effects, and medical treatment.

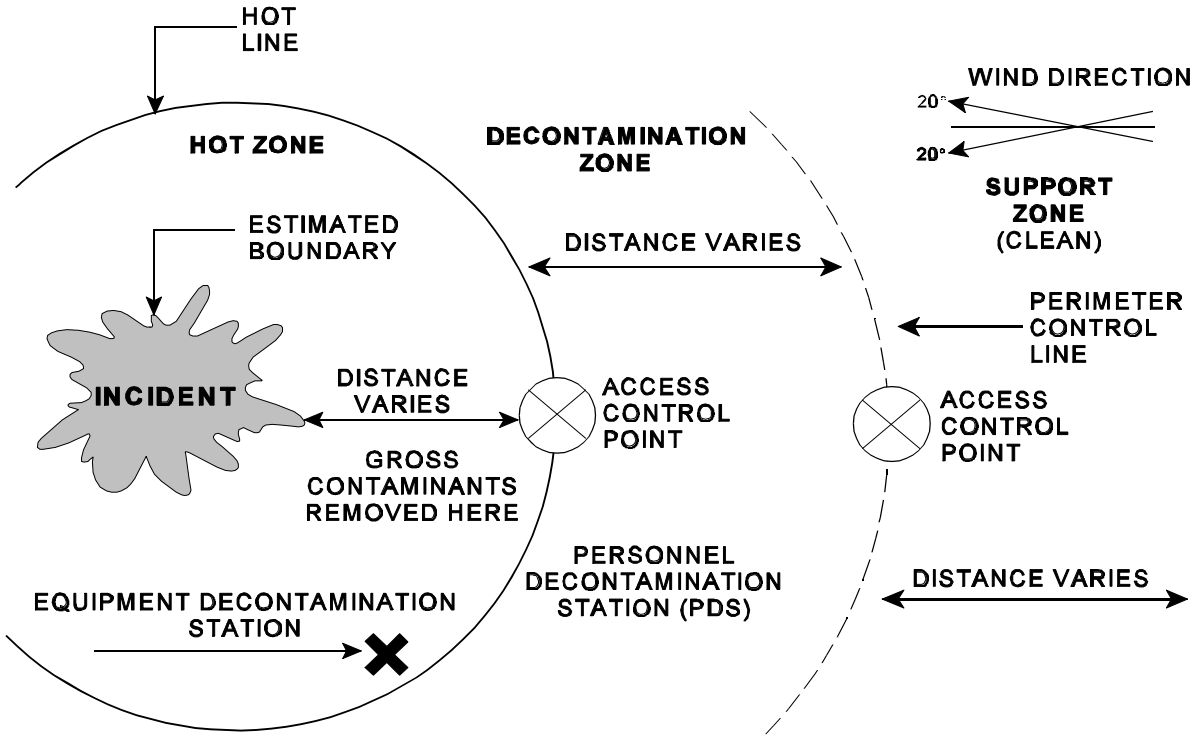
- Determine the potential for secondary contamination. Understand the risk to yourself and to others in the Support Zone, ambulance, or hospital if decontamination is not completed at the scene.

- Perform appropriate and thorough decontamination.

- Provide basic and advanced life support (ALS).

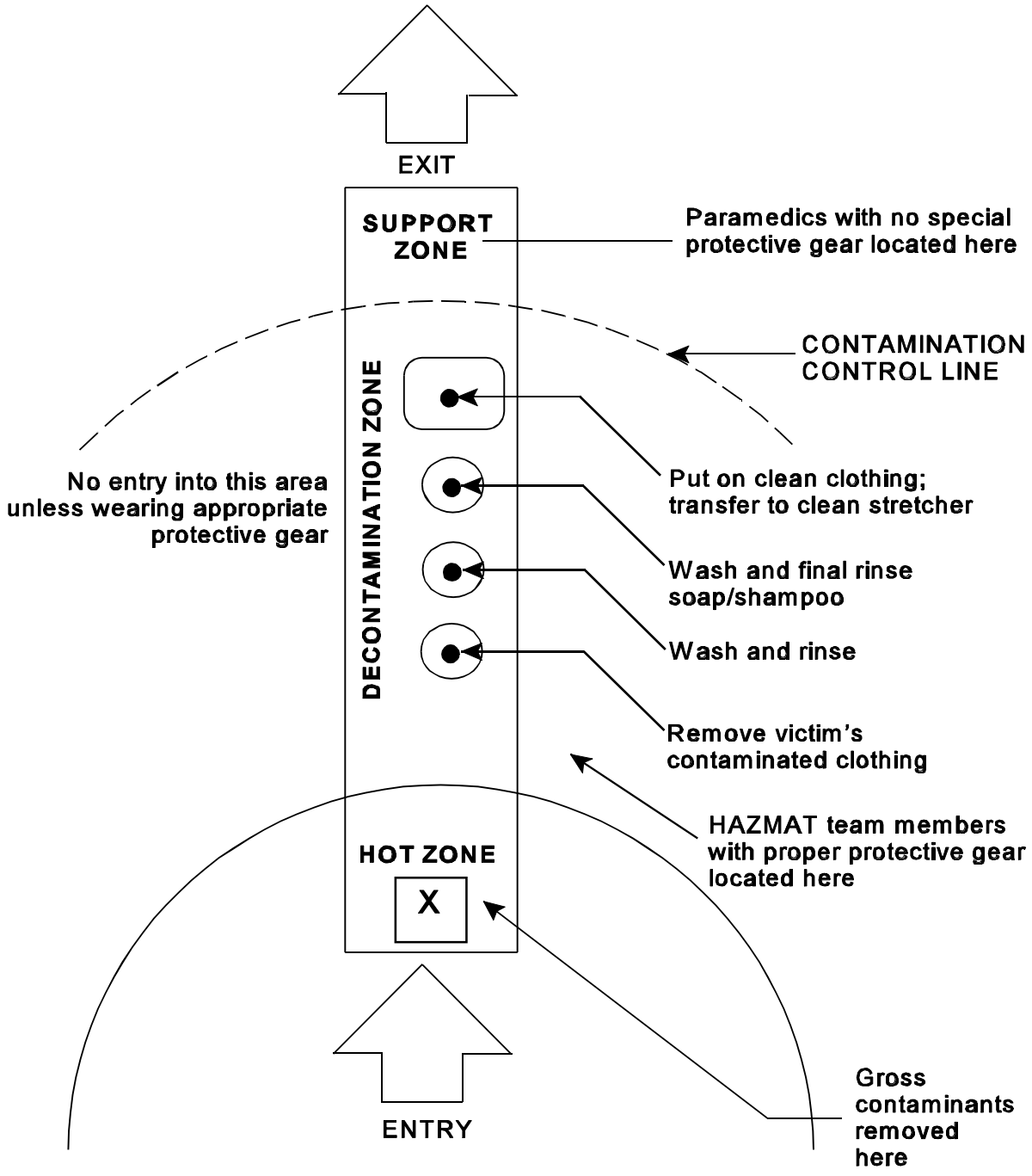
- Transport victims to an appropriate medical facility as quickly as possible.

Figure 1. Organization of a HAZMAT incident area




Adapted from Olson, KR, ed. Poisoning and drug overdose. Norwalk, CT: Appleton and Lange, 1990.

Figure 2. Detail of decontamination zone




Adapted from Hazardous material medical management protocols, 2nd edition. Sacramento, CA: Emergency Medical Services Authority, 1991.

# Prehospital Management Section

- **Potential for secondary contamination**
- **Health effects expected from an acute exposure**
- **Patient care (supportive care, antidotes)**

Secondary contamination is discussed on page 3 of the *Introduction*.

In the prehospital setting, the key factors in determining the potential for secondary contamination are the route and extent of exposure. Victims exposed only to gas or vapor are not likely to carry significant amounts of chemical beyond the Hot Zone and are not likely to endanger personnel outside the Hot Zone. However, victims whose skin, hair, or clothing is grossly contaminated with solid or liquid chemical (including condensed vapor) may contaminate personnel by direct contact or by off-gassing vapor. Victims who have ingested a toxic chemical may expose others through toxic vomitus or by vapor off-gassing from toxic vomitus.

*The bold text below is from the Unidentified Chemical protocol. It is presented as an example of the information presented in each section. The plain g&ace provides details or an explanation.*

## Hot Zone

**Rescuers should be trained and appropriately attired before entering the Hot Zone. If the proper equipment Is not available, or if rescuers have not been trained in its use, assistance should be obtained from a local or regional HAZMAT team or other properly equipped response organization**.

The Hot Zone includes the area immediately around the chemical spill where persons may be in danger from chemical exposure or physical hazards (e.g., fire or explosion). Only persons who have specialized HAZMAT training should enter the Hot Zone. Although some of these persons may be trained as paramedics, only limited medical care can be provided in the Hot Zone. Advanced medical care is provided in the Decontamination Zone and Support Zone.

## Rescuer Protection

When a chemical is unidentified, worst-case possibilities concerning toxicity must be assumed. 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.

**Respiratory Protection: Pressure-demand, self-contained breathing apparatus (SCBA) should be used in all response situations.**

**Skin Protection: Chemical-protective clothing should be worn when local and systemic effects are unknown.**

Trained responders should select protective equipment and clothing based on the general regulations in 29 CFR 1910.120 (OSHA Hazardous waste operations and emergency response).

The protocols contain chemical-specific recommendations for rescuer protection. The Rescuer Protection section begins with a summary of the health hazards that are pertinent for one-time, short-term exposures such as those expected at a HAZMAT incident. The respiratory-tract and skin protection (e.g., respirators and chemical-protective clothing) recommendations are based on these health hazards.

Two basic types of respiratory protection are available: atmosphere-supplying and air-purifying respirators. Atmosphere-supplying respirators provide compressed air at greater than atmospheric pressure to a face mask that is worn by the rescuer and may be supplied-air or self-contained.

The self-contained breathing apparatus (SCBA) is often used in HAZMAT incident response to prevent inhalation of hazardous chemicals because it is self-contained, portable, and familiar. SCBA consists of a facepiece that seals, a tank of compressed air carried on the back, and a hose that runs from the air tank to the facepiece. The specific type of SCBA recommended in the Guidelines is “pressure demand”; that is, although air is always flowing into the facepiece (pressure), the flow increases in response to inhalation (demand).

Although commonly used at hazardous waste clean-up sites, the supplied-air respirator should not be used at a HAZMAT incident. The supplied-air respirator consists of a mask or facepiece connected to an air hose supplied by a compressor at a distant site. Because the air hose may be degraded by chemicals or heat and the hose may become tangled, the supplied-air respirator is not practical for operations during an emergency.

Air-purifying respirators do not supply air to the user; they simply filter the ambient air and are seldom used at HAZMAT incidents. Air-purifying respirators can use the same type of facepiece as an air-supplied respirator. Instead of an air-supply hose, they are connected to a charcoal or other filter-containing cartridge. The cartridge filters the air before it is inhaled. Conditions that preclude the use of an air-purifying respirator include

- oxygen-deficient atmosphere (19.5% $O_2$)
- unidentified contaminant
- unknown concentration of contaminant
- concentration of contaminant above NIOSH IDLH
- high relative humidity

Most HAZMAT incidents involve at least one of these conditions; therefore, air-purifying respirators are rarely appropriate for emergency response.

Dust or surgical masks are also air-purifying-they filter and prevent the inhalation of large particles. However, they offer no protection from the inhalation of chemical vapors or gases and are not recommended in the Guidelines.

Regardless of the type of respiratory protection used, all respirators should be approved by NIOSH and the Mine Safety and Health Administration(MSHA).NIOSH and MSHA designate performance characteristics of respirators.

Chemical-protective clothing (CPC) is not subject to performance standards set by a government agency. Chemical-specific resistance to degradation, penetration, and permeation are important factors to consider in selecting CPC. CPC that fails can subject the wearer to significant exposure and adverse health effects. Degradation involves the chemical breakdown of the suit material itself, causing exposure. Penetration is movement of a chemical through an opening in the material or article of clothing (e.g., through punctures or zippers). Permeation involves chemical movement through the suit material but not necessarily destruction of it.

The NFPA has established performance standards for two types of chemical-protective garments: a vapor-protective suit and a liquid-splash-protective suit. The standards provide methods for testing material and suits to assure chemical resistance, overall durability, and valve/closure construction suitability. The vapor protective suit is completely encapsulating; once the user is attired, even exhaled air is trapped inside until pressure activates

one-way release valves. Suits meeting the NFPA guidelines can be used to provide protection according to the EPA classifications described below. The certification accompanying protective clothing that meets NFPA guidelines specifies the chemicals and conditions under which the clothing was tested. The NFPA performance standards do not address respiratory protection; therefore, no assumptions can be made regarding respiratory protection based on the NFPA suit designation.

EPA has established a 4-stage classification system to address the levels of protection afforded by respiratory and chemical-protective clothing combinations commonly used by HAZMAT responders. The four classes, in descending order of protection, are called levels A through D. The EPA definitions do not address NFPA clothing; however, the equivalent NFPA suit is specified below.

**Level A** includes a fully encapsulating chemical-resistant suit (equivalent to an NFPA vapor-protective suit) and a pressure-demand SCBA.

**Level B** includes a nonencapsulating chemical-resistant suit (equivalent to an NFPA splash-protective suit) and an SCBA.

**Level C** includes a nonencapsulating chemical-resistant suit (equivalent to an NFPA splash-protective suit) and an air-purifying respirator.

**Level D** consists of work clothes that do not provide any specific respiratory or skin protection.

The EPA classification does not address use of the common fire-fighting ensemble - SCBA with “turnouts” or “bunker” gear. Turnouts are not designed to protect against chemical exposure and should not be worn when hazardous chemical exposure is possible.

Specialized personal protective gear should be used only by those with prior training and fitting. The choice of specific chemical-resistant materials (e.g., Tyvek, Saranex, or butyl rubber) is beyond the scope of this document and is generally the responsibility of an expert on the HAZMAT team. Additional protective equipment may be required when risks of fire or explosion exist.

Although CPC provides protection against adverse health effects due to chemical exposure, it contributes to heat stress. CPC prevents both the inward and. outward movement of moisture, decreasing the availability of evaporative cooling. During an incident, body heat builds quickly because of the heavy workload and CPC prevents heat dissipation. Several cooling systems are available for use under CPC; however, they serve only to reduce peripheral body temperature and not core body temperature. Because core body temperature does not decrease, cooling systems may actually be harmful. By cooling the skin and making the user feel more comfortable, cooling systems may encourage rescuers to work longer and build up a dangerously high core body temperature.

*ABC Reminders*

**Quickly ensure a patent airway. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible.**

Only minimal patient care can be performed in the Hot Zone while wearing Level A or Level B protective gear. Rescuers can often perform only simple maneuvers such as ensuring a patent airway, applying a cervical collar, brushing off gross contaminants, and applying direct pressure to stop arterial bleeding. The goal in the Hot Zone is to quickly remove the victim from continued exposure and risk.

*Victim Removal*

**If victims can walk, lead them out of the Hot Zone to the Decontamination Zone. Victims who are unable to walk may be removed on backboards or gurneys; if these are not available, carefully carry or drag victims to safety.**

Victims should be removed from the Hot Zone to the Decontamination or Support Zone, as appropriate, in the safest and quickest way possible. Ambulatory victims may need to be guided to the Decontamination Zone. Nonambulatory victims can be removed on backboards, litters, or gurneys, or if necessary, carefully dragged or carried to safety.

## Decontamination Zone

Victims exposed only to gas or vapor who have no skin or eye irritation may be transferred immediately to the Support Zone. All others require decontamination (see Basic Decontamination, page 25).

The Decontamination Zone is a corridor between the Hot Zone and the Support Zone. The Decontamination Zone may be set up in any convenient location that is safely beyond the Hot Zone, but

separate from the Support Zone. If possible, the Decontamination Zone should be established outdoors (preferably upwind and uphill from the Hot Zone) where natural ventilation will allow dispersion of vapor off-gassing from contaminated victims. Because personnel in the Decontamination Zone normally require protective gear, only trained HAZMAT-team members should be present.

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

*Rescuer Protection*

**If the chemical or concentration is unidentified, personnel in the Decontamination Zone should wear the same protective equipment used in the Hot Zone (see Rescuer Protection, page 19).**

Personnel in the Decontamination Zone normally require protective gear; only personnel with prior fitting and training should be permitted to don protective gear. Generally, the level of clothing is the same as that worn in the Hot Zone. A lower level of protective clothing can be used when the risk of secondary contamination is low. For example, a nonencapsulating suit (NFPA splash protective suit) can be used if an 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 must be identified and measured to assure safety before a lesser level of respiratory protection is used.

*ABC Reminders*

Quickly ensure a patent airway. Stabilize the cervical spine with a collar and a backboard if trauma Is suspected. Administer supplemental oxygen as required. Assist ventilation with a bag valve-mask device If necessary.

To provide airway, breathing, and circulatory support for patients in the Decontamination Zone, the rescuer may have to establish an artificial airway, administer supplemental oxygen or nebulized bronchodilators, and assist ventilation. Direct pressure should be applied to control heavy bleeding. Depending on the concentration of the chemical and its potential for secondary contamination, victims with serious trauma or medical complications (e.g.,

seizures) may have to wait for advanced medical care until gross contamination is removed.

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 are not taken into the Decontamination Zone because the equipment may not be safe to operate and may be difficult to decontaminate.

*Basic Decontamination*

**Victims who are able and cooperative may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings.**

Consider bagging the victim's jewelry and other valuables separately from clothing for easier retrieval later. Nonporous materials such as metal jewelry may be easy to decontaminate by washing, whereas clothing or shoes may require disposal. Leather items can be especially difficult to decontaminate and may need to be incinerated. Consult a HAZMAT specialist affiliated with the local fire department, the ATSDR/CDC Emergency Response 24-hour Hotline ([404] 639-0615) or the EPA Environmental Response Team, Edison, New Jersey ([732] 321-6740) for advice on the disposition of contaminated equipment and clothing.

**Flush exposed or irritated skin and hair with water for 3 to 5 minutes. For oily or otherwise adherent chemicals, use mild soap on the skin and hair.**

**Flush exposed or irritated eyes with plain water or saline for at least 5 minutes. Remove contact lenses if present and easily removable without additional trauma to the eye. If a corrosive material is suspected or if pain or injury is evident, continue irrigation while transferring the victim to the Support Zone.**

Many chemicals react violently with water, liberating toxic gases or creating explosions. Cautions about water reactivity (e.g., statement in the DOT Emergency Response Guidebook or in an MSDS) generally do not apply to flushing eyes, skin, and hair in the Decontamination Zone. There is little risk of creating a serious reaction hazard by adding large amounts of water to the small amount of residual chemical on the victim's body. In fact, the naturally occurring moisture on the skin is already reacting with

the chemical; hastening removal from the skin is preferable to leaving the chemical to further injure the victim.

Solids should be gently brushed from hair, skin, and clothing. During brushing, protect the victim's eyes, nose, and mouth. The length of time recommended for flushing exposed skin or eyes will vary with the chemical and the circumstances of exposure. Removal of oily or insoluble materials from the skin and hair requires washing with soap. Any liquid hand- or dish-washing soap will be satisfactory. Use only soft-bristled brushes; abrasive brushing may enhance skin injury and penetration. Most chemicals that cause only mild skin or eye irritation can be removed by flushing for 3 to 5 minutes. Ten to 15 minutes may be required for concentrated or strongly alkaline materials. Eye decontamination after exposure should be continued while the patient is transferred to the Support Zone and even during transport to a medical facility. An attempt should be made to remove contact lenses. Avoid forceful removal, which may inflict injury. Irrigation and transfer to the Support Zone should not be delayed because of difficulty in removing contact lenses.

Bleach, vinegar, or other solutions used for equipment decontamination should not be used for washing skin, hair, or eyes. Likewise, neutralizing agents should not be used for decontamination because the heat from neutralization may cause added injury. Dilution with large volumes of water is preferred for decontamination.

**In cases of ingestion, do not induce emesis. Victims who are conscious and able to swallow should be given 4 to 8 ounces of water. Obtain medical care immediately.**

Generally, vomiting should not be induced. Vomiting is relatively ineffective in emptying the stomach after a chemical ingestion and may be harmful to the victim. Vomiting may increase damage to the esophagus and stomach if irritating or corrosive chemicals have been ingested. The risk of pulmonary aspiration is also increased when vomiting occurs.

Activated charcoal adsorbs many chemicals and is relatively easy to administer. Unless a corrosive chemical has been ingested, a slurry of 50 to 60 grams of activated charcoal should be given to an adult patient who is awake and has a gag reflex. Charcoal may obscure the view when endoscopy is performed (at the hospital) to determine the extent of injury. See Ingestion Exposure, page

40, for further discussion of gastrointestinal-tract decontamination.

*Transfer to Support Zone*

**As soon as basic decontamination is complete, move the victim to the Support Zone.**

Victims should be moved from the Decontamination Zone to the Support Zone as soon as possible. Ambulatory patients can walk; others may require transport on a gurney.

**Support Zone**

**Be certain that victims have been decontaminated properly. Victims who have undergone decontamination or have been exposed only to gas or vapor and who have no evidence of skin or eye irritation generally pose no serious risks of secondary contamination. In such cases, Support Zone personnel require no specialized protective gear.**

Because the Support Zone is set up away from the dangers of physical hazards or chemical exposures, primary contamination is not a serious problem in this area. Personnel in the Support Zone do not require special protective clothing if victims have been decontaminated properly. An exception involves victims exposed to a potent and adherent chemical (e.g., an organophosphate pesticide), in which case the Support Zone team should wear disposable aprons or gowns and latex gloves.

*ABC Reminders*

Quickly ensure a patent airway. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible. Ensure adequate respiration; administer supplemental oxygen as required. Ensure a palpable pulse. Establish intravenous access if necessary. Attach a cardiac monitor. More sophisticated medical management can begin in the Support Zone where rescuer movement is less encumbered and more equipment and personnel are available. Initially, this care is centered on airway, breathing, and circulatory support for the patient. Intravenous lines should be inserted as soon as possible. A cardiac monitor should be attached because of the potential for some chemicals (e.g., halogenated or aromatic hydrocarbons) to produce dysrhythmogenic effects.

*Additional Decontamination*

**Continue irrigating exposed skin and eyes, as appropriate.**

**In cases of ingestion, do not induce emesis. If the patient is conscious and able to swallow, administer 4**

**to 8 ounces of water if it has not been given previously. Obtain medical care immediately**.

Some victims may require continued irrigation of irritated skin and eyes. If a cardiac monitor is required, irrigation should be completed before the monitor is attached. The additional decontamination recommendations do not imply that the victim poses a risk of secondary contamination. Exposure to a concentrated or strongly alkaline material may require continued irrigation of eyes and skin during transport and in the hospital. Eye irrigation is easily and conveniently accomplished using saline or water and intravenous tubing attached to a nasal canula placed over the bridge of the nose with the prongs pointed down toward the eyes.

Ingestion exposure is an uncommon occurrence in a HAZMAT incident. If ingestion has occurred and initial gastrointestinal decontamination has not been carried out in the Decontamination Zone, appropriate treatment must be instituted in the Support Zone. Gastrointestinal decontamination procedures should be carried out only if the patient is alert and has a gag reflex.

For most chemicals, the protocols do not recommend emesis and in some cases (e.g., exposure to corrosives or hydrocarbons), emesis is contraindicated. Many chemicals are effectively adsorbed on the surface of charcoal. When indicated in the protocol, a slurry of activated charcoal should be administered as soon as possible to prevent gastrointestinal absorption. If the chemical is corrosive or has not been identified, rinse the mouth and throat by administering 6 to 8 ounces of water. The water will also dilute the hazardous material in the stomach.

*Advanced Treatment*

**Intubate the trachea in cases of respiratory compromise. When the patient's condition precludes endotracheal intubation, perform cricothyroidotomy if equipped and trained to do so.**

**Treat patients who have bronchospasm with aerosolized bronchodilators. Use these and all catecholamines with caution because of the enhanced risk of cardiac dysrhythmias after exposure to certain chemicals.**

**Patients who are comatose, hypotensive, or have seizures or cardiac dysrhythmias should be treated according to ALS protocols.**

In the Support Zone, more advanced medical care can be readily administered. Contact the regional poison control center (see Appendix 1) or the hospital base station for advice specific to the incident.

Bronchodilators, such as metaproterenol (Alupent or Metaprel) or albuterol (Proventil or Ventolin), can be administered by metered-dose inhaler, or preferably, by hand-held nebulizer. However, these medications increase heart rate and may provoke cardiac dysrhythmias in victims who have been exposed to certain chlorinated or aromatic hydrocarbons. When bronchodilators are needed, the lowest effective dose should be given and cardiac rhythm should be monitored.

Evaluate the patient for possible opioid overdose or hypoglycemia and administer naloxone (Narcan) and dextrose according to standard ALS protocols. Consider the possibility that coma or seizures may be the result of trauma (e.g., head injury) rather than of chemical poisoning.

Administer specific antidotes as described in the chemical-specific protocols if within the prehospital scope of practice.

*Transport to Medical Facility*

**Report to the base station and the receiving medical facility the condition of the patient, treatment given, and estimated time of arrival at the medical facility.**

**If a chemical has been ingested, prepare the ambulance in case the victim vomits toxic material. Have ready several towels and open plastic bags to quickly clean up and isolate vomitus.**

The base station and receiving medical facility should be apprised of the patients' status. Special procedures for patient care en route can be discussed, especially if transport time will be lengthy. Notifying the medical facility of your arrival time ensures appropriate emergency department preparation.

Before transporting patients who have ingested hazardous materials, prepare the ambulance by lining a basin or bucket with open plastic bags to catch and isolate toxic vomitus. Some chemicals are converted to poisonous gases by the action of stomach acids (e.g., cyanide salts create hydrogen cyanide gas; sodium azide can produce hydrazoic acid gas). Toxic vomitus can contaminate personnel and equipment by direct contact or by off-gassing volatile chemicals.

Ambulances that transport HAZMAT victims require only standard equipment. Most supplies recommended in the *Guidelines* are standard equipment or are easily obtained from grocery or drug stores. The specific equipment most likely to be used in HAZMAT response will vary with the training and policies of individual emergency medical services agencies, but at a minimum include the following:

- disposable gloves
- splash goggles
- waterproof disposable shoe covers
- disposable gowns to cover EMS personnel clothing and to be used by stripped and decontaminated patients
- large supply of oxygen
- plastic garbage bags
- large wash basin 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

Only 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 decontaminated effectively, no danger of secondary contamination exists. Use of the body bag technique is not effective and puts the victim at risk of substantial skin injury and absorption.

## Multi-Casualty Triage

**All exposed patients should be transported to a medical facility for evaluation.**

**Asymptomatic patients who have not had direct chemical exposure can be discharged from the scene after their names, addresses, and telephone numbers are recorded. Those discharged should be advised to seek medical care promptly if symptoms develop.**

**Consult with the base station physician or regional poison control center for further advice regarding triage of multiple victims.**

Triage is a complex process that identifies victims who have the most serious injuries and who can benefit most from rapid treatment and transport. The Multi-Casualty Triage section in each protocol makes general recommendations for transport

priorities based only on the chemical; however, the base station physician or regional poison control center (see Appendix I) should give advice for specific situations.

## *Emergency Department Management Section*

The *Guidelines*, which represent a state-of-the-art, practical approach to the management and treatment of HAZMAT victims, are based on the consensus of a panel of experts. However, the user of the protocols should be aware that large data gaps exist in the scientific literature and knowledge regarding the treatment of patients exposed to hazardous substances is constantly evolving. The protocols are not a substitute for the professional judgment of a health care provider and must be interpreted in light of specific information regarding the patient and in conjunction with other sources of authority.

**Goals of the Hospital Provider in HAZMAT Incidents:**

- Determine the potential for secondary contamination.
- If necessary, decontaminate patients.
- Provide supportive and antidotal emergency care (resources for toxicity information include the *Guidelines* and a regional poison control center [*Appendix I*]).
- Obtain appropriate laboratory tests.
- Arrange for observation, hospital admission, and follow-up care as needed.

## *Emergency Department Management Section*

- **Potential for secondary contamination**
- **Health effects expected from an acute exposure**
- **Patient care (supportive care, antidotes)**

Secondary contamination is discussed on page 3 of the introduction. Victims who were exposed only to gas or vapor or who were decontaminated at the scene are not likely to pose a risk of secondary contamination to hospital personnel. However, victims whose skin, hair, or clothing is grossly contaminated with solid or liquid chemical (including condensed vapor) may endanger health care personnel by direct contact or by off-gassing vapor. Toxic vomitus can also expose hospital personnel directly or through off-gassing vapor.

### Decontamination Area

**Previously decontaminated patients and patients exposed only to gas or vapor who have no evidence of skin or eye irritation may be transferred immediately to the Critical Care Area. Other patients will require decontamination as described below.**

Basic decontamination should be carried out at the scene of the incident before the victim is transports, however, this does not always occur. For example, a contaminated victim might be brought directly to the emergency department by a coworker. Hospitals should plan for the arrival of contaminated victims.

Contaminated victims received in indoor facilities create potentially serious risks of secondary contamination to hospital personnel, especially if materials are volatile. Many hospital protocols suggest shutting off the ventilation system to protect the hospital from cross-contamination. However, lack of ventilation may compound the risk to emergency department personnel attending the victim. Very few hospitals have the financial resources to properly construct a separate decontamination room with appropriate ventilation.

Basic decontamination is safely and practically performed outside in a naturally ventilated area adjacent to the ambulance entrance. Suggested equipment and supplies for an outdoor hospital Decontamination Area include the following:

- Gurney with plastic tub or run-off collector. (Several companies make disposable or reusable decontamination

tables or foldable rubber tubs that can be placed on top of a gurney.)

- A warm-water source with a hose and soft-stream shower head
- Disposable chemical-resistant jumpsuits (e.g., of Tyvek or Saranex)
- Chemical-resistant gloves (e.g., of butyl rubber) in different sizes
- Rubber aprons
- Mild soap and shampoo
- Soft-bristled brushes
- Splash-protective goggles or other protective eye wear
- Wading pool for decontamination of ambulatory patients
- Plastic garbage bags
- Oxygen tanks with delivery supplies
- Disposable towels and gauze
- Surgical scrubs for decontaminated patients
- Extra blankets and sheets for patient privacy and warmth
- Portable privacy barriers (do not totally enclose decontamination area or natural ventilation will be lost)

*ABC Reminders*

**Evaluate and support airway, breathing, and circulation. Intubate the trachea in cases of respiratory compromise. If the patient's condition precludes Intubation, surgically create an airway.**

**Treat patients who have bronchospasm with aerosolized bronchodilators; use these and all catecholamines wlth caution because of the potential enhanced risk of cardiac dysrhythmias.**

**Patients who are comatose, hypotensive, or have seizures or ventricular dysrhythmias should be treated in the conventional manner.**

Generally, decontamination is performed before treatment is started. However, basic airway, breathing, and circulation must be addressed in victims who have life-threatening symptoms. Patients heavily contaminated with highly toxic organophosphate insecticides pose great risks of secondary contamination to health care personnel; patients should not be touched until staff is appropriately gloved and gowned. Persons soaked with flammable materials cannot be treated with DC countershock until decontamination has been carried out because of risk of fire and explosion. Simultaneous treatment and decontamination of patients should be carried out whenever possible.

*Basic Decontamination*

**Patients who are able and cooperative may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings.**

For easier retrieval, consider bagging the victim's jewelry and other valuables separately from clothing. Nonporous materials such as metal jewelry may be easy to decontaminate by washing, whereas clothing or shoes may require disposal. Leather items can be especially difficult to decontaminate and may need to be incinerated.

**Flush exposed or irritated skin and hair with plain water for 3 to 5 minutes. For oily or otherwise adherent chemicals, use mild soap on the skin and hair. Rinse thoroughly with water.**

**Flush exposed or irritated eyes with plain water or saline for at least 5 minutes. Remove contact lenses if present and easily removable without additional trauma to the eye. If a corrosive material is suspected or if pain or injury is evident, continue irrigation while transferring the patient to the Critical Care Area.**

Some chemicals react violently with water, liberating toxic gases or creating explosions. Cautions about water reactivity (e.g., the statements in the DOT Emergency Response Guidebook or in an MSDS) generally do not apply when decontaminating victims with water. Adding large amounts of water to the small amount of residual chemical on the victim's body poses little risk of creating a serious reaction hazard. In fact, the naturally occurring moisture on the skin will react with the chemical; hastening removal of the chemical from the skin is preferable to leaving it to potentially cause further injury.

Solid contaminants should be gently brushed from hair, skin, and clothing. During brushing, protect the victim's eyes. The length of time for flushing exposed skin or eyes with water will vary with the chemical and the circumstances of exposure. Chemicals that cause only mild skin or eye irritation can be flushed for 3 to 5 minutes. Concentrated or strongly alkaline materials may require 10 to 15 minutes. Eye decontamination may be continued while the patient is transferred to the Critical Care Area. An attempt should be made to remove contact lenses. Avoid forceful removal that may inflict injury. Difficulty in removing contact lenses should not delay irrigation or transfer to the Critical Care Area.

Removal of oily or insoluble materials from the skin and hair requires washing with soap or shampoo. Any liquid hand- or dish-washing soap is satisfactory. Use only soft-bristled brushes; abrasive brushing may enhance skin injury and penetration.

Bleach, vinegar, or solutions used for decontaminating equipment should not be used for washing skin, hair, or eyes. Neutralizing agents should not be used because the heat of the neutralization may cause added injury. Flooding volumes of water are preferable.

**In cases of ingestion, do not induce emesis. Administer 4 to 8 ounces of water to dilute stomach contents if the patient is conscious and able to swallow. Immediately transfer the patient to the Critical Care Area.**

Emesis is not generally recommended in the protocols. Vomiting is relatively ineffective in emptying the stomach after a chemical ingestion and may be harmful to the victim. Vomiting may increase the risk of pulmonary aspiration or damage to the esophagus and stomach if irritating or corrosive chemicals have been ingested.

Activated charcoal adsorbs many chemicals and is relatively easy to administer. For most chemical ingestions, a slurry of 50 to 60 grams of activated charcoal should be administered to an adult patient who is awake and has a gag reflex. If a corrosive chemical has been ingested, do not administer activated charcoal because it may obscure the view when endoscopy is performed. See Critical Care Area below for further discussion of gastrointestinal decontamination.

## Critical Care Area

If appropriate decontamination efforts have been completed before entry to the Critical Care Area, special precautions, such as covering floors and walls with plastic or shutting off the ventilation system, are not needed. However, if the patient has ingested a chemical, prepare to isolate toxic vomitus quickly (see Ingestion Exposure, page 40).

**Be certain that appropriate decontamination has been carried out. (See Decontamination Area, page 33.)**

ED personnel in the Critical Care Area generally do not need specialized protective gear. However, if risk of residual skin contamination exists (e.g., potent chemicals, such as some organophosphate pesticides, or radioactive dust), water-resistant gowns or aprons, latex gloves, and eye-splash protection ate

necessary. Emergency medical care providers usually carry these protective items for universal infection control or communicable disease control.

*ABC Reminders*

**Evaluate and support airway, breathing, and circulation as in ABC Reminders, page 34. Establish intravenous access in seriously ill patients. Continuously monitor cardiac rhythm.**

**Patients who are comatose, hypotensive, or have seizures or ventricular dysrhythmias should be treated in the conventional manner**.

Many chemicals can cause progressive airway injury or systemic illness with delayed onset. Watch for signs of laryngeal edema and respiratory system compromise, such as progressive hoarseness, strider, hypoventilation, or cyanosis.

Consider the possibility of exposure to multiple chemicals as well as multiple-system injuries. For example, smoke inhalation can cause airway injury because of heat and irritant chemicals and coma from asphyxiants such as carbon monoxide and cyanide.

Consider possible opioid overdose and evaluate for hypoglycemia; administer naloxone (Narcan) and dextrose according to usual protocols. Treat patients who have seizures with conventional anticonvulsants (e.g., diazepam, phenytoin, or phenobarbital). Consider the possibility that coma or seizures may be from a head injury or from alcohol or other drug intoxication, rather than from hazardous material exposure.

Place an intravenous line in all patients who are unconscious, obtunded, hypotensive, or may become so. Patients exposed to substances that may cause cardiac sensitization or intravascular hemolysis may also require intravenous access. An initial bolus of an appropriate intravenous solution should be given. The fluid should be titrated to maintain acceptable urine output and blood pressure. Care must be taken not to overhydrate the patient.

Treat patients who have hypotension using rapid infusions of normal saline (250 mL to 1 L in adults). Use dopamine or other inotropic drugs for persistent hypotension. Hypotension may be complicated by hypothermia or hyperthermia. Hypothermia should be considered if the victim was stripped and decontaminated with cold water or in a cold ambient setting. Hyperthermia may result from certain systemic poisons (e.g., dinitrophenol).

*Inhalation Exposure*

**Administer supplemental oxygen by mask to patients who have respiratory complaints. Treat patients who have bronchospasm with aerosolized bronchodilators; use these and all catechola mines with caution because of the potential or possible enhanced risk of cardiac dysrhythmias.**

Bronchodilators may provoke ventricular dysrhythmias in some patients who have been exposed to aromatic or halogenated hydrocarbons.

Although pulse oximetry is a convenient way to continuously monitor oxygenation in patients, it is unreliable or falsely normal in patients who have dyshemoglobinemias (e.g., methemoglobinemia or carboxyhemoglobinemia) because it measures only oxygen dissolved in the blood and not the status of tissue oxygenation. In patients who have altered hemoglobins, the pulse oximeter does not reflect the impaired oxygen carrying or delivery capacity of the red cells. In these situations, a Co-Oximeter should be used to measure specific levels of hemoglobins unable to transport oxygen.

Chemically induced pulmonary edema is due to leaky pulmonary alveoli, not left ventricular failure as is cardiogenic pulmonary edema. Patients who have chemically induced pulmonary edema do not benefit from digoxin, morphine, afterload reduction, or diuretics. Supplementary oxygen, delivered by mechanical ventilation and positive end-expiratory pressure, if needed, are standard treatments for chemically induced (noncardiogenic) pulmonary edema.

Corticosteroids and antibiotics have been commonly recommended for treatment of chemical pneumonitis, but their effectiveness has not been substantiated.

Soluble irritants (e.g., ammonia or hydrogen chloride) rapidly produce respiratory effects; poorly soluble irritants (e.g., phosgene and some nitrogen oxides) produce slow onset of airway irritation and respiratory distress. Poorly soluble agents are commonly associated with delayed (12 to 72 hours) onset pulmonary edema. The time period for developing pulmonary edema varies with the chemical and is noted in each individual protocol. Watch for signs of respiratory distress and intubate if necessary.

*Skin Exposure*

**If chemical burns are present, treat as thermal burns.**

The extent and depth of injury in a chemical burn is often not immediately apparent; hence the severity of the bum is frequently underestimated. Loss of circulating fluid may occur. In addition, dermal absorption of a corrosive chemical may contribute to systemic toxicity.

Patients who have been exposed to highly corrosive, penetrating, oily, or persistent chemicals may require additional or continuous decontamination. Residues may remain in the armpits, groin, buttocks, hair, ears, nostrils, and under the fingernails and toenails. If the material is highly contaminating (e.g., organophosphate pesticides or radioactive dust), care givers should wear gowns and gloves to protect themselves.

Use liquid soap for cleansing the skin and hair. Special decontaminating agents are recommended for only a few chemicals (see specific protocols).

*Eye Exposure*

**Ensure that adequate eye irrigation has been completed. Test visual acuity. Examine the eyes for corneal damage using a magnifying device or a slit lamp and fluorescein stain. For small corneal defects, use ophthalmic antibiotic ointment or drops, analgesic medication, and an eye patch. Immediately consult an ophthalmologist for patients who have corneal injuries**.

Ensure that contact lenses have been removed, that no visible residual material is in the conjunctival sac, and that the pH of the conjunctival fluid is normal.

Irrigation is easily continued in a hospital setting using intravenous tubing to provide a steady, low-pressure stream of water or saline. A Morgan Lenscan also be placed to provide continuous, thorough eye decontamination. Do not use neutralizing or other decontaminating solutions.

A corneal burn or abrasion can easily be seen with the aid of fluorescein stain, a UV light source, and a magnifier or slit lamp. The disrupted corneal surface allows accumulation of the fluorescein, which fluoresces under UV light. If serious injury is evident (e.g., extensive corneal fluorescein accumulation, cloudy or bloody material in the anterior chamber, or obvious perforation of the globe), an ophthalmologist should be consulted immediately.

*Ingestion Exposure*

**Do not Induce emesis. If the patient is alert and charcoal has not been given previously, administer a slurry of activated charcoal. If a corrosive material is suspected, administer 4 to 8 ounces of water; do not give a slurry of activated charcoal. Consider endoscopy to evaluate the extent of gastrointestinal-tract injury. If a large dose has been ingested and the patient's condition is evaluated within 30 minutes after ingestion, consider gastric lavage.**

Ingested chemicals and products formed by their reaction with stomach acid may be hazardous to ED personnel through direct contact with vomitus or by inhalation of the gases liberated from the vomitus. For example, ingested cyanide salts are converted to highly toxic hydrogen cyanide gas in the stomach. Staff must take measures, therefore, to isolate toxic vomitus or gastric washings. This can be done by attaching the lavage tube to isolated wall suction or other closed container.

Activated charcoal is capable of adsorbing most chemicals and should be given as early as possible. Even chemicals that have relatively poor adsorption to charcoal (e.g., cyanide and alcohols) are still bound to some extent. Charcoal may need to be removed by gastric washing before endoscopy can be performed. Corrosive liquids should be removed from the stomach as early as possible. However, care must be taken when placing the gastric tube because blind gastric-tube placement may further injure the chemically damaged esophagus or stomach.

*Antidotes and Other Treatments*

**Treatment consists of supportive measures.**

The individual guidelines provide information on the use of specific antidotes.

*Laboratory Tests*

**Routine laboratory studies for all exposed patients include CBC, glucose, and electrolyte determinations. Additional studies for patients exposed to an unidentified chemical Include ECG monitoring, renal-function tests, and liver-function tests. Chest radiography and pulse oximetry (or ABG measurements) are recommended for severe inhalation exposure.**

All patients should have CBC, glucose, and electrolyte determinations. Additional, specific recommendations are listed in the laboratory tests section to aid both diagnosis and treatment.

Laboratory test results are often within normal range immediately after an exposure but may become abnormal after a delay of several hours or even days, depending on the specific chemical exposure. For example, chest radiography may not show signs of pulmonary edema for 12 to 24 hours and signs of liver injury may not appear for 2 to 3 days following exposure. Pulse oximetry and routine arterial blood gas determination of $Po_2$ tests may provide falsely normal, unreliable, or misleading results in patients with abnormal hemoglobin states (e.g., methemoglobinemia or carboxyhemoglobinemia).

Tests to measure a specific chemical contaminant in biologic samples are rarely available on an emergency basis. The turn-around time may be several hours to days; hence, these tests rarely are clinically useful. However, the results of these tests may aid in confirming or documenting exposure. A regional poison control center (*Appendix I*) can assist with the selection and interpretation of specialized laboratory tests.

## Disposition and Followup

**Consider hospitalizing patients who have a suspected serious exposure and persistent or progressive symptoms.**

Patient disposition should be determined based on the symptoms, the intrinsic toxicity of the chemical, and course of illness. Some patients may be safely discharged from the emergency department while others will require prolonged observation or intensive care.

### *Delayed Effects*

**When the chemical has not been identified, the patient should be observed for an extended period or admitted to the hospital.**

The usual duration of observation in an emergency department is 6 to 8 hours. If the chemical agent is known to produce delayed-onset illness or is unidentified, the asymptomatic patient should be admitted for observation.

### *Patient Release*

**Asymptomatic patients who have minimal exposure, normal initial examinations, and no signs of toxicity after 6 to 8 hours of observation may be discharged with instructions to seek medical care promptly if symptoms develop.**

Each protocol includes a detailed Patient Information Sheet with a list of possible delayed symptoms. This sheet should be reviewed with the patient before discharge. A signed copy should be

included in the medical chart, and a copy sent home with the patient.

Do not release clothing or personal items to the patient before a determination of residual contamination is made. Most items can be reused after washing. However, some contaminated articles cannot be rendered safe for reuse (e.g., leather goods, such as shoes, that are contaminated with methyl bromide or organophosphate pesticides). Some articles will require disposal at a hazardous waste site or by incineration. Consult a HAZMAT specialist affiliated with the local fire department or the ATSDR/CDC Emergency Response 24-hour Hotline ([404] 639-0615) for advice on the disposition of contaminated personal effects.

*Followup*

Provide the patient with follow-up instructions to return to the emergency department or a private physician to reevaluate initial findings. Patients who have corneal injuries should be reexamined within 24 hours.

*Appendix II* contains the telephone numbers and addresses of members of the Association of Occupational and Environmental Clinics (AOEC). These clinics employ specialists in the diagnosis and treatment of chemically exposed patients. They may provide consultation and follow-up advice.

## Reporting

**If a work-related incident has occurred, you may be legally required to file a report; contact your state or local health department.**

**Other persons may still be at risk in the setting where this incident occurred. If the incident occurred in the workplace, discussing it with company personnel may prevent future incidents. If a public health risk exists, notify your state or local health department or other responsible public agency. When appropriate, inform patients that they may request an evaluation of their workplace from OSHA or NIOSH. See *Appendices III* and IV for a list of agencies that may be of assistance.**

*Appendix III* contains the telephone numbers of state health departments. In addition to filing a report, state health departments or the EPA's Environmental Response Team, Edison, New Jersey ([732] 321-6740) may be able to assist in determining procedures for the cleaning of hospital facilities and equipment.

You may also advise your patients to call the regional OSHA office to report a suspected violation of safe work practices. Appendix IV contains the numbers of the NIOSH office that may be of assistance.

# Patient Information Sheet

The Patient Information Sheet provides information and follow-up instructions for persons who have been exposed to the chemical. It is written in an easy to understand question and answer format and addresses the questions most often asked. It is intended to be given to the patient.

The follow-up instructions on the back of the Patient Information Sheet are statements that the clinician can check off if they apply to the patient. The instructions include a list of signs and symptoms specific to each chemical (and directions to the patient to seek medical care if they occur); directions for obtaining follow-up appointments; and restrictions on activities, medications, alcohol and cigarette smoke. Space is provided for the clinician to write other instructions.

# *Appendix I*

## *AAPCC-Certified Regional Poison Control Centers*

# AAPCC-Certified Regional Poison Control Centers

Poison Control Centers were established around 1953 to help physicians deal with poisoning of adults and children in the United States. In 1983, the American Association of Poison Control Centers (AAPCC) was established as the professional organization for Poison Control Centers. The Regional Poison Control Centers can act as a valuable resource in providing information about the toxicity and health effects of hazardous exposures involved in poisonings.

**ALABAMA**
Alabama Poison Center
2503 Phoenix Drive
Tuscaloosa AL35405
Emergency: (800) 462-0800 (AL only)
(205)345-0600

Children's Hospital of Alabama Poison Control Center
1600 7th Avenue South
Birmingham AL 35233
Emergency: (800) 292-6678 (AL only)
(205) 933-4050

**ALASKA**
Anchorage Poison Control Center
3200 Providence Drive
P.O. Box 196604
Anchorage AK 99519
Emergency: (800) 478-3193
(907) 261-3193

**ARIZONA**
Arizona Poison and Drug Information Center
Arizona Health Sciences Center
Room 1156
1501 North Campbell Avenue
Tuscon AZ 85724
Emergency: (800) 362-0101 (AZ only)
(602) 626-6016

Samaritan Regional Poison Center
Good Samaritan Regional Medical Center
1111 E. McDowell–Ancillary 1
Phoenix AZ 85006
Emergency:(800) 362-0101 (AZ only)
(602) 253-3334

**ARKANSAS**
Arkansas Poison and Drug Information Center
College of Pharmacy
University of Arkansas for Medical Sciences
Mail Slot 552
4301 W. Markham
Little Rock AR 77205
Emergency: (800) 376-4766
TDD/TTY (800) 641-3805

**CALIFORNIA**
California Poison Control System-Fresno/Madera
Valley Children's Hospital
9300 Valley Children's Place
Madera CA 93638
Emergency: (800) 876-4766 (CA only)

California Poison Control System-Sacramento
UC Davis Medical Center
2315 Stockton Boulevard
Sacramento CA 95817
Emergency: (800) 876-4766 (CA only)

California Poison Control System-Dan Diego
UC San Diego, Medical Center
200 West Arbor Drive
San Diego CA 92103
Emergency: (800) 876-4766

California Poison Control System-San Francisco
San Francisco General Hospital
1001 Potrero Avenue, Room 1E86
San Francisco CA 94110
Emergency: (800) 876-4766 (CA only)

**COLORADO**
Rocky Mountain Poison and Drug Center
9902 E. Ninth Avenue
Denver CO 80220
Emergency: (800) 332-3073 (CO only/outside metro area)
(303) 739-1123 (Denver metro)

**CONNECTICUT**
Connecticut Poison Control Center
University of Connecticut Health Center
263 Farmington Avenue
Farmington CT 06030
Emergency: (800) 343-2722 (CT only)
(860) 679-3456

**DELAWARE**
The Poison Control Center
3535 Market Street, Suite 985
Philadelphia PA 19104
Emergency: (800) 772-7112
(215) 386-2100

**DISTRICT OF COLUMBIA**
National Capitol Poison Control Center
3201 New Mexico Avenue, NW
Suite 310
Washington DC 20016
Emergency: (202) 625-3333
TDD/TTY: (202) 362-8563 (TTY)

**FLORIDA**
Florida Poison Information Center-Jacksonville
655 West Eighth Street
Jacksonville FL 32209
Emergency: (800) 282-3171 (FL only)
(904) 549-4480

Florida Poison Information Center-Miami
University of Miami
Department of Pediatrics
P.O. Box 016960 (R-131)
Miami FL 33101
Emergency: (800) 282-3171 (FL only)
(305) 585-5253

**FLORIDA (continued)**
Florida Poison Information Center-Tampa
Tampa General Hospital
P.O. Box 1289
Tampa FL 33601
Emergency: (800) 282-3171 (FL only)
(813) 253-4444

**GEORGIA**
Georgia Poison Center
Hughes Spalding Children's Hospital
Grady Health System
80 Butler Street, SE, P.O. Box 26066
Atlanta GA 30335
Emergency: (404) 606-9000
TDD/TTY: (404) 606-9287 (TDD)

**HAWAII**
Hawaii Poison Center
1319 Punahou Street
Honolulu HI 96826
Emergency: (808) 941-4411

**IDAHO**
Rocky Mountain Poison and Drug Center
8802 E. Ninth Avenue
Denver CO 80220
Emergency: (800) 860-0620 (ID only)

**ILLINOIS**
Illinois Poison Center
222 S. Riverside Plaza, Suite 1900
Chicago IL 60606
Emergency: (800) 942-5969 (IL only)

**INDIANA**
Indiana Poison Center
Methodist Hospital
I-65 at 21st Street
Indianapolis IN 46206
Emergency: (800) 382-9097 (IN only)
(317) 929-2323
TDD/TTY: (317) 929-2336 (TTY)

**IOWA**
Iowa Poison Center
St. Luke's Regional Medical Center
2720 Stone Park Boulevard
Sioux City IA 51104
Emergency: (800) 352-2222
(712) 277-2222

**IOWA (continued)**
Poison Control Center
Department of Pharmaceutical Care,CC101 GH
The University of Iowa Hospitals and Clinics
200 Hawkins Drive
Iowa City IA 52242
Emergency: (800) 272-6477 (IA only)

**KANSAS**
Mid-American Poison Control Center
University of Kansas Medical Center
3901 Rainbow Blvd., Room B-400

Kansas City KS 66160
Emergency: (800) 332-6633
(913) 588-6633
TDD/TTY: (913) 588-6639 (TDD)

**KENTUCKY**
**Louisville**
Kentucky Regional Poison Center
Medical Towers South, Suite 572
234 East Gray Street
Louisville KY 40202
Emergency: (502) 589-8222

**LOUISIANA**
Louisiana Drug and Poison Information Center
Unitversity of Louisiana at Monroe
College of Pharmacy
Sugar Hall
Monroe, LA 71209
Emergency: (800) 256-9822 (LA only)

**MAINE**
Maine Poison Control Center
Maine Medical Center
22 Bramhall Street
Portland ME 04102
Emergency: (800) 442-6305 (ME only)
(207) 871-2950

**MARYLAND**
Maryland Poison Center
University of MD at Baltimore
School of Pharmacy
20 North Pine Stree, PH230
Baltimore MD 21201
Emergency: (800) 492-2414 (MD only)
(410) 528-7701
TDD/TTY: (410) 706-1858

National Capitol Poison Control Center
3201 New Mexico Avenue, NW
Suite 310
Washington DC 20016
Emergency: (202) 625-3333
TDD/TTY: (202) 362-8563 (TTY)

**MASSACHUSETTS**
Regional Center for Poison Control and Prevention Services for Massachusetts and Rhode Island
300 Longwood Avenue
Boston MA 02115
Emergency: (800) 682-9211 (MA and RI only)
(617)232-2120

**MICHIGAN**
Regional Poison Control Center
Chidren's Hospital of Michigan
4160 John R Harper Professional Office Bldg, Suite 616
Detroit MI 48201
Emergency: (800) 764-7661 (MI only)
(313) 745-5711
TTD/TTY: (800) 356-3232 (TTY)

Spectrum Health Regional Poison Center
1840 Wealthy S.E.
Grand Rapids MI 49506
Emergency: (800) 764-7661 (MI only)
TTD/TTY: (800) 356-3232 (TTY)

**MINNESOTA**
Hennepin Regional Poison Center
Hennepin County Medical Center
701 Park Avenue
Minneapolis MN 55415
Emergency: (800) POISON1 (MN and SD only)
(612) 347-3141
TDD/TTY: (612) 904-4691 (TTY)

PROSAR International Poison Control Center
1295 Bandana Boulevard
Suite 335
St. Paul MN 55108
Emergency: (888) 779-7921

**MISSISSIPPI**
Mississippi Regional Poison Control Center
University of Mississippi Medical Center
2500 N. State Street
Jackson MS 39216
Emergency: (601) 354-7660

**MISSOURI**
Regional Poison Center
Cardinal Glennon Children's Hospital
1465 S. Grand Blvd.
St. Louis MO 63104
Emergency: (800) 366-8888
(314) 772-5200

**MONTANA**

Rocky Mountain Poison and Drug Center
8802 E. Ninth Avenue
Denver CO 80220
Emergency: (800) 525-5042 (MT only)

**NEBRASKA**
The Poison Center
Children's Hospital
8301 Dodge Street
Omaha NE 68114
Emergency: (800) 955-9119 (NE and WY only)
(402) 354-5555

**NEVADA**
Oregon Poison Center
Oregon Health Sciences University
3181 SW Sam Jackson Park Road
Portland OR 97201
Emergency: (503) 494-8968

**NEVADA (continued)**
Rocky Mountain Poison and Drug Center
8802 E. Ninth Avenue
Denver CO 80220
Emergency: (800) 446-6179 (NV only)

**NEW HAMPSHIRE**
New Hampshire Poison Information Center
Dartmouth-Hitchcock Medical Center
One Medical Center Drive
Lebanon NH 03756
Emergency: (800) 562-8236 (NH only)
(603) 650-8000

**NEW JERSEY**
New Jersey Poison Information and Education System
201 Lyons Avenue
Newark NJ 07112
Emergency: (800) POISON-1 (NJ only)

**NEW MEXICO**
New Mexico Poison and Drug Information Center
Health Science Center Library
Room 125
University of New Mexico
Albuquerque NM 87131
Emergency: (800) 432-6866 (NM only)
(505) 272-2222

**NEW YORK**
Central New York Poison Center
750 East Adams Street
Syracuse NY 13210
Emergency: (800) 252-5655 (NY only)
(315) 476-4766

Finger Lakes Regional Poison and Drug Information Center
University of Rochester Medical Center
601 Elmwood Avenue
P.O. Box 321
Rochester NY 14642
Emergency: (800) 333-0542 (NY only)
(716) 275-3232
TDD/TTY: (716) 273-3854 (TTY)

**NEW YORK (continued)**
Hudson Valley Regional Poison Center
Phelps Memorial Hospital Center
701 North Broadway
Sleepy Hollow NY 10591
Emergency: (800) 336-6997 (NY only)
(914) 366-3030

Long Island Regional Poison Control Center
Winthrop University Hospital
259 First Street
Mineola NY 11501
Emergency: (516) 542-2323
(516) 663-2650
TTD/TTY: (516) 924-8811 (TDD Suffolk)
(516) 747-3323 (TDD Nassau)

New York City Poison Control Center
NYC Department of Health
455 First Avenue
Room 123, Box 81
New York NY 10016
Emergency: (800) 210-3985
(212) 340-4494; (212) POI-SONS;
(212) VEN-ENOS
TDD/TTY: (212) 689-9014 (TDD)

Western New York Regional Poison Control Center
Children's Hospital of Buffalo
219 Bryant Street
Buffalo NY 14222
Emergency: (800) 888-7655 (NY western regions only)
(716)-878-7654

**NORTH CAROLINA**
Carolinas Poison Center
Carolinas Medical Center
5000 Airport Center Parkway, Suite B
Charlotte NC 28208
Emergency: (800) 848-6946 (NC only)
(704) 355-4000

**NORTH DAKOTA**
North Dakota Poison Information Center
Meritcare Medical Center
720 4th Street North
Fargo ND 58122
Emergency: (800) 732-2200 (ND, MN, SD only)
(701) 234-5575

**OHIO**
Central Ohio Poison Center
700 Children's Drive, Room L032
Columbus OH 43205
Emergency: (800) 682-7625 (OH only)
(800) 762-0727 (Dayton, OH only)
TDD/TTY: (614) 228-2272

Cincinnati Drug and Poison Information Center
Regional Poison Control System
2368 Victory Parkway, Suite 300
Cincinnati OH 45206
Emergency: (800) 872-5111 (OH only)
(513) 558-5111

Greater Cleveland Poison Control Center
11100 Euclid Avenue
Cleveland OH 44106
Emergency: (888) 231-4455
(216) 231-4455

**OKLAHOMA**
Oklahoma Poison Control Center
Children's Hospital of Oklahoma
940 N.E. 13th Street, Room 3512
Oklahoma City OK 73104
Emergency: (800) 764-7661 (OK only)
(405) 271-5454

**OREGON**
Oregon Poison Center
Oregon Health Sciences University
3181 SW Sam Jackson Park Road
Portland OR 97201
Emergency: (800) 452-7165 (OR only)
(503)494-8968

**PENNSYLVANIA**
Central Pennsylvania Poison Center
Penn State Geisinger Health System
The Milton S. Hershey Medical Center
MC HO453 PO Box 850
500 University Drive
Hershey PA 17033
Emergency: (800) 521-6110
TDD/TTY: (717) 531-8335

Pittsburgh Poison Center
Children's Hospital of Pittsburgh
3705 Fifth Avenue
Pittsburgh PA 15213
Emergency: (412) 681-6669

The Poison Control Center
3535 Market Street, Suite 985
Philadelphia PA 19104
Emergency: (800) 772-7112
(215) 386-2100

**RHODE ISLAND**
Regional Center for Poison Control and Prevention Services for Massachusetts and Rhode Island
300 Longwood Avenue
Boston MA 02115
Emergency: (617) 232-2120

**SOUTH CAROLINA**
Palmetto Poison Center
College of Pharmacy
University of South Carolina
Columbia SC 29208
Emergency: (800) 922-1117 (SC only)
(803) 777-1117

**SOUTH DAKOTA**
Hennepin Regional Poison Center
Hennepin County Medical Center
701 Park Avenue
Minneapolis MN 55415
Emergency: (800) POISON1 (MN and SD only)
(612) 347-3141
TDD/TTY: (612) 904-4691 (TTY)

**TENNESSEE**
Middle Tennessee Poison Center
The Center for Clinical Toxicology
501 Oxford House
1161 21st Avenue South
Nashville TN 37232
Emergency: (800) 288-9999 (TN only)
(615) 936-2034 (Greater Nashville)
TDD/TTY: (615) 936-2047 (TDD)

Southern Poison Center
875 Monroe Avenue
Suite 104
Memphis TN 35163
Emergency: (800) 288-9999 (TN only)
(901) 528-6048

**TEXAS**
Central Texas Poison Center
Scott and White Memorial Hospital
2401 South 31st Street
Temple TX 76508
Emergency: (800) POISON-1 (TX only)
(254) 724-7401

North Texas Poison Center
Texas Poison Center Network
Parkland Health and Hospital System
5201 Harry Hines Blvd.
P.O. Box 35926
Dallas TX 75235
Emergency: (800) POISON-1 (TX only)

South Texas Poison Center
The University of Texas Health Science Center-San Antonio
Forensic Science Building, Room 146
Department of Surgery
7703 Floyd Curl Drive
San Antonio TX 78284
Emergency: (800) 764-7661 (TX only)

Southeast Texas Poison Center
The University of Texas Medical Branch
3.112 Trauma Building
Galveston TX 77555
Emergency: (800) 764-7661 (TX only)
(409) 765-1420

**TEXAS (continued)**
Texas Panhandle Poison Center
1501 S. Coulter
Armarillo TX 79106
Emergency: (800) 764-7661 (TX only)

West Texas Regional Poison Center
Thomason Hospital
4815 Alameda Aveue
El Paso TX 79905
Emergency: (800) 764-7661 (TX only)

**UTAH**
Utah Poison Control Center
410 Chipeta Way, Suite 230
Salt Lake City UT 84108
Emergency: (800) 456-7707 (UT only)
(801) 581-2151

**VERMONT**
Vermont Poison Center
Fletcher Allen Health Care
111 Colchester Avenue
Burlington VT 05401
Emergency: (877) 658-3456 (toll free)

**VIRGINIA**
Blue Ridge Poison Center
University of Virginia Health System
PO Box 800774
Charlottesville VA 22908
Emergency: (800) 451-1428 (VA only)

National Capitol Poison Control Center
3201 New Mexico Avenue, NW
Suite 310
Washington DC 20016
Emergency: (202) 625-3333
TDD/TTY: (202) 362-8563 (TTY)

Virginia Poison Center
Medical College of Virginia Hospitals
Virginia Commonwealth University
PO Box 980552
Richmond VA 23298
Emergency: (800) 552-6337

**WASHINGTON**
Washington Poison Center
155 NE 100th Street, Suite 400
Seattle WA 98125
Emergency: (800) 732-6985 (WA only)
(206) 526-2121
TDD/TTY: (206) 517-2394 (TDD)
(800) 572-0638 (TDD WA only)

**WEST VIRGINIA**
West Virginia Poison Center
3110 MacCorkle Ave., S.E.
Charleston WV 25304
Emergency: (800) 642-3625 (WV only)

**WISCONSIN**
Children's Hospital of Wisconsin Poison Center
PO Box 1997
Milwaukee WI 53201
Emergency: (800) 815-8855 (WI only)
(608) 262-3702

**WYOMING**
The Poison Center
Children's Hospital
8301 Dodge Street
Omaha NE 68114
Emergency: (800) 955-9119 (NE and WY only)
(402) 354-5555

**ANIMAL POISON CENTER**
ASPCA
National Animal Poison Control Center
1717 South Philo Road
Suite 36
Urbana IL 61802
Emergency: (888) 426-4435
(900) 680-0000

# *Appendix II*

## *Association of Occupational and Environmental Clinics*

## Association of Occupational and Environmental Clinics (AOEC)

Professionals in the AOEC act as consultants for treatment of persons exposed to hazardous substances.

**ALABAMA**
University of Alabama at Birmingham
930 20th Street South
Birmingham, AL 35205
(205) 975-2767; FAX (205) 975-4377
Timothy J. Key, MD, MPH

**ARIZONA**
Samaritan Occupational and Environmental Toxicology Clinic
Department of Medical Toxicology
925 E. McDowell Rd., Second Floor
Phoenix AZ 85006
(602) 239-6690; FAX (602) 239-4138
Kevin Wallace, MD

**CALIFORNIA**
Occupational & Environmental Medicine Clinic
University of California at San Francisco/SFGH
Building 30, 5th floor,
1001 Potrero Avenue
SanFrancisco CA 94110
(415) 206-4320; FAX (415) 206-8949
Patricia Quinlan, MPH, CH
Alt. Contact:
Denise Souza, RN, MSN, OHNP, COHN-S

UCSF Occupational Health Services
University of California at San Francisco
2380 Sutter Street, 3rd Floor
San Francisco, CA 94115
(415) 885-7580; FAX (415) 771-4472
Robert Harrison, MD, MPH
Alt. Contact: Leslie Israel, DO, MPH

Occupational & Environmental Health Clinic
Employee Health Services
University of California, Davis Medical Center
Primary Care Building, Suite A
2221 Stockton Blvd.
Sacramento CA 95817
(916) 734-8393; FAX (916) 734-7510
Appointments: (916) 734-8393
Stephen McCurdy, MD, MPH

**CALIFORNIA (continued)**

Occupational & Health Environmental Clinic
University of California at Irvine
Center for Occupational and Environmental Health
19722 MacArthur Blvd.
Irvine CA 92715
(949)-824-8641; FAX (949) 824-2345
Dean Baker, MD, MPH

**COLORADO**
Division of Environmental & Occupational Health Sciences
National Jewish Medical Research Center Center
1400 Jackson Street
Denver CO 80206
(303) 398-l520; FAX (303) 398-l452
Appointments (303) 398-1733
Peggy Mroz, MSPH
Alt. Contact: Cecile Rose, MD, MPH

Toxicology Associates
2555 S. Downing Street #260
Denver CO 80210
(303) 765-3800; FAX (303) 765-3804
Scott Phillips, MD, FACP

**CONNECTICUT**
Yale Occupational & Environmental Medicine Program
135 College Street, 3rd Floor
New Haven, CT 06510
(203) 785-7267; FAX (203) 785-7391
Mark R. Cullen, MD
Alt. Contact: Peter M. Rabinowitz, MD, MPH

University of Connecticut
Occupational and Environmental Medicine Program
263 Farmington Avenue
Farmington, CT 06030
(860) 679-2893; FAX (860) 679-4587
Eileen Storey, MD, MPH

**CONNECTICUT (continued)**
Northwest Connecticut Occupational Medical Center
333 Kennedy Drive, Suite 202
Torrington CT 06790
(860) 482-4552; FAX (860) 489-4647
Gregory E. McCarthy, MD

**DISTRICT OF COLUMBIA**
Division of Occupational and Environmental Medicine
School of Medicine, George Washington University
2300 K Street, NW
Washington, DC 20037
(202) 994-1734; FAX (202) 994-0011
Tee L. Guidotti, MD, MPH
Alt. Contact: Katherine Hunting, PhD, MPH

Section of Occupational & Environmental Medicine
Washington Hospital Center
110 Irving St., NW
Washington, DC 20010-2975
(202) 877-5466; FAX (202) 877-4136
Laura Welch, MD

**GEORGIA**
Environmental and Occupational Medicine Consultative Clinic
The Emory Clinic
1525 Clifton Road, NE, Rm 404
Atlanta, GA 30322
(404) 778-5978; FAX (404) 727-8744
Howard Frumkin, MD, Dr. PH

**ILLINOIS**
Occupational Medicine Clinic
Cook County Hospital
1900 W. Polk, Rm 500
Chicago IL 60612
(312) 633-5310; FAX (312) 633-6442
Rachel Rubin, MD, MPH
Alt. Contact :Ann Naughton, RN, MPH, COHN

University of Illinois Occupational Medicine Program
914 S. Wood, M/C 684
Chicago IL 60612
(312) 996-7420; FAX (312) 413-8485
Linda Forst, MD, MPH

**IOWA**
University of Iowa, Occupational Medicine Clinic
Department of Internal Medicine, College of Medicine
200 Hawkins Drive, C33-GH
Iowa City, IA 52242
(319) 356-4419; FAX (319) 356-7147
Gary Hunninghake, MD

**KENTUCKY**
University of Kentucky Occupational Medicine Program
2400 Greatstone Point
Lexington, KY 40504
(606) 257-5150; FAX (606) 257-8982
Terrence Collins, MD, MPH

**LOUISIANA**
Ochsner Center for Occupational Health
1514 Jefferson Highway
New Orleans, LA 70121
(504) 842-3955; FAX (504) 842-3977
Gregg A. Bendrick, MD, MPH
Alt. Contact: Lori Brown

Tulane Centers for Occupational Health
1415 Tulane Avenue, Box HC31
New Orleans LA 70112
(540) 736-5333; FAX (504) 736-4835
Douglas A. Swift, MD, MPH

**MARYLAND**
Johns Hopkins University
Center for Occupational and Environmental Health
5501 Hopkins Bayview Circle
Baltimore, MD 21224
(410) 550-2322; FAX (410) 550-3355
Edward J. Bernacki, MD, MPH

Occupational Health Project
University of Maryland School of Medicine
405 Redwood Street
Baltimore, MD 21201
(410) 706-7464; FAX (410) 706-4078
Janie Gordon, ScM

**MASSACHUSETTS**

Caritas Good Samaritan Occupational Health Services
Merchants Building
75 Stockwell Dr.
Avon MA 02322
(508) 427-3900; FAX (508) 427-3905
Robert Naparstek, MD

Center for Occupational and Environmental Medicine
Massachusetts Respiratory Hospital
2001 Washington Street
South Braintree, MA 02184
(781) 848-2600; FAX (718) 849-3290
Dianne Plantamura, MSW, Coordinator
Alt. Contact: David Christiani, MD, MPH, MS

Occupational Health Program
Department of Family and Community Medicine
University of Massachusetts
55 Lake Avenue North
Worcester, MA 10655
(508) 856-2818; FAX (508) 856-l 680
Tom Hicks, MD, MPH

Occupational and Environmental Health Center
Cambridge Hospital
1493 Cambridge Street
Cambridge, MA 02139
(617) 665-1580; FAX (617) 665-1671
Rose Goldman, MD, MPH

Occupational & Environmental Health Center
Children's Hospital
300 Longwood Ave
Boston MA 02115
(617) 355-8177; FAX (617) 738-0032
Michael Shannon, MD, MPH
Alt. Contact: Alan Woolf, MD, MPH

**MICHIGAN**

Michigan State University
Department of Medicine
117 Est Fee
East Lansing, MI 48824
(517) 353-1846; FAX (517) 432-3606
Appointments: (517) 353-4941
Kenneth Rosenman, MD

**MICHIGAN (continued)**

Division of Occupational and Environmental Health
Wayne State/Department of Family Medicine
4201 Street Antoine, Suite 4J
Detroit, Ml 48201
(313) 577-l 420; FAX (313) 577-3070
Appointments/Clinic: (313) 745-4093
Maryjean Schenk, MD, MPH

Occupational Health Program
School of Public Health, University of Michigan
1420 Washington Heights
Ann Arbor, Ml 48109
(734) 764-2594; FAX (734) 763-8095
David Garabrant, MD, MPH
Alt. Contact: Alfred Franzblau, MD

Center for Occupational and Environmental Medicine
22255 Greenfield Rd., Suite 440
Southfield, MI 48075
(248) 559-6663; FAX (248) 559-8254
Laura Harbut, EMT, MBA

Occupational Health Service
St. Lawrence Hospital Work and Health Institute
1210 W. Saginaw
Lansing, MI 48915
(517) 377-0309; FAX (517) 377-0310
R. Michael Kelly, MD, MPH

**MINNESOTA**

HealthPartners-Regions Hospital
Occupational & Environmental Medicine
640 Jackson St.
St. Paul, MN 55101-2595
(651) 221-3771; FAX (651) 221-8848
Paula Geiger
Alt. Contact: William H. Lohman, MD

Columbia Park Medical Group
Occupational Medicine Department
6401 University Ave., NE #200
Minneapolis MN 55432
(612) 572-5710; FAX (612) 571-3008
Donald Johnson, MD
Alt. Contact: Dorothy Quick

**NEW JERSEY**
Environmental and Occupational Health Clinical Center
Environmental and Occupational Health Sciences Institute
UMDNJ-Robert Wood Johnson Medical School
170 Frelinghuysen Rd.
Piscataway, NJ 08854
(732) 445-0123; FAX (732) 445-0127
Howard Kipen, MD, MPH
Alt. Contact: Gail Buckler, RN, MPH, COHN-S

**NEW MEXICO**
Presbyterian Occupational Medicine Clinic
5901 Harper, NE
PO Box 26666
Albuquerque NM 87125
(505) 823-8450; FAX (505) 823-8484
William I. Christensen, MD, MPH

Occupational and Environmental Medicine Clinic
2400 Tucker NE, Rm 177
Albuquerque NM 87131
(505) 272-2900; FAX (505) 272-4494
Karen B. Mulloy, DO, MSCH

**NEW YORK**
Eastern NY Occupational & Environmental Health Center
155 Washington Avenue
Albany NY 12210
(518) 436-5511; FAX (518) 436-9110
Anne Tencza, BS, RN, COHN-S
Alt. Contact: Eckardt Johanning, MD

Mount Sinai -Irving J. Selikoff Center for Occupational and Environmental Medicine
P.O. Box 1058
Gustave Levy Place
New York, NY 10029
(212) 241-0176; FAX (212) 996-0407
Appointments: (212) 987-6043
Stephen Mooser, MPH
Alt. Contact: Stephen Levin, MD

**NEW YORK (continued)**
Center for Occupational & Environmental Medicine
School of Medicine
Health Sciences Center, Level 3-086
University at Stony Brook
Stony Brook, NY 11794
(516) 444-2196; FAX (516) 444-7525
Wajdy Hailoo, MD, Msc, DIH

Central NY Health Clinical Center
6712 Brooklawn Parkway
Suite 204
Syracuse, NY 13211
(315) 432-8899; FAX (315) 431-9528
Michael B. Lax, MD, MPH

New York University/Bellevue Hospital Occupational and Environmental Medicine Clinic
Bellevue Hospital, Room CD 349
462 1st Avenue
New York, NY 10016
(212) 562-4572; FAX (212) 562-4574
George Friedman-Jimenez, MD

Finger Lakes Occupational Health Services
980 Westfall Road, Suite 210
Rochester NY 14618
(716) 256-0843; FAX (716) 256-2271
Deanna Woodhams, MA

**NORTH CAROLINA**
Division of Occupational and Environmental Medicine
Duke University Medical Center
Box 3834
Durham, NC 27710
(919) 286-3232; FAX (919) 286-1021
Dennis J. Darcey, MD, MSPH
Alt. Contact: Gary Greenberg, MD, MPH

**OHIO**
Community Health Partners Occupational Health Center
The Lorain Clinic for Occupational Medicine &

Rehabilitation
1800 Livingston Ave
Lorain OH 44052
(440) 233-1068; FAX (440) 246-4560
Kathleen Fagan, MD, MPH
Alt. Contact: Ann Wise, MD

Center for Occupational Health
Holmes Hospital-Tate Wing
University of Cincinnati College of Medicine
Eden and Bethesda Avenue
Cincinnati, OH 45267
(513) 584-1234; FAX (513) 584-1010
James Donovan, MD, MS
Alt. Contact: Susan Pinney, MD

**OKLAHOMA**
University Occupational Health Services
Division of Occupational and Environmental Medicine
Oklahoma Memorial Hospital
900 NE 10th Street, #2400
Oklahoma City, OK 73104
(405) 271-6177; FAX (405) 271-4125
David Paul, MD, MPH

**OREGON**
Occupational Health Program
Oregon Health Sciences University (OHSU)
3181 SW Sam Jackson Park Rd.
Mail Code OP-20C
Portland OR 97201
(503) 494-1027; FAX (503) 494-4457
Nina Wolf, RN, BSN, COHN-S

**PENNSYLVANIA**
Occupational and Environmental Medicine Program
University of Pittsburgh
3708 Fifth Avenue, Suite 401,
Medical Arts Bldg.
Pittsburgh, PA 15261
(412) 647-5360; FAX (412) 647-1140
Joseph J. Schwerha, MD, MPH

**PENNSYLVANIA (continued)**
University of Pennsylvania School of Medicine
Occupational Medicine-Silverstein Pavilion
3400 Spruce Street
Philadelphia, PA 19104
(215) 349-5708; FAX (215) 662-3953
Appointments: (215) 662-2354
Edward A. Emmett, MD

Center for Occupational and Environmental Health
Abington Memorial Hospital
2510 Maryland Road, Suite 101
Willow Grove, PA 19090
(215) 481-5909; FAX (215) 481-5920
Lora S. Regan, MD, MPH

**TENNESSEE**
Occupational and Environmental Medicine Clinic
Meharry Medical College
1005 D.B. Todd Boulevard
Nashville TN 37208
(615) 327-6736; FAX (615) 327-6717
Otis Cosby, MD, MPH
Alt. Contact: Herman Ellis, MD, MPH

**TEXAS**
Texas Institute of Occupational Safety & Health
11937 U.S. Highway 271
Tyler, TX 75708
(903) 877-5900; FAX (903) 877-7982
Jeffrey Levin, MD, MPH

University of Texas Health Services
7000 Fannin, Suite 1620
Houston TX 77030
(713) 500-3267; FAX (713) 500-3263
Thomas Mackey, RNC, PhD

**UTAH**
Rocky Mountain Center for Occupational and Environmental Health
75 South 2000 East
University of Utah
Salt Lake City, UT 84112
(801) 581-3841; FAX (801) 581-7224
Appointments: (801) 581-5056
Anthony Suruda, MD, MPH
Alt. Contact: Royce Moser, MD, MPH

**VIRGINIA**
Carillon Occupational Medicine
Falin Center
903 S. Jefferson Street
Roanoke, VA 24016
(540) 985-9820; FAX (540) 985-8118
Elaine Gill
Alt. Contact: Hetzal Hartley, MD, MPH

**WASHINGTON**
Occupational and Environmental Medicine Program
University of Washington Harborview Medical Center
325 9th Avenue, #359739
Seattle, WA 98104
(206) 731-3005; FAX (206) 731-8247
Drew Brodkin, MD, MPH
Alt. Contact: Scott Barnhart, MD, MPH

**WEST VIRGINIA**
Division of Occupational & Environmental Health
Department of Family and Community Medicine
Marshall University School of Medicine
1600 Medical Center
Huntington, WV 25755
(304) 691-1178; FAX (304) 691-1153
Chris McGuffin, MSCH, MSOSH
Alt. Contact: James Becker, MD

**WEST VIRGINIA (continued)**
Institute of Occupational & Environmental Health
West Virginia University School of Medicine
3801 Robert F. Byrd health Science Center South
Morgantown WV 26506
(304) 293-3693; FAX (304) 293-2629
Alan Ducatman, MD, Msc

**CANADIAN CLINICS**

**ALBERTA**
Occupational Medicine Consultation Clinic
University of Alberta
13-103 Clinical Science Bldg.
Edmonton Alberta, CD T6G 2G3
(780) 492-6291; FAX (780) 492-0364
Jim Cheng, MD

**MANITOBA**
MFL Occupational Health Centre, Inc.
102-275 Broadway
Winnipeg, Manitoba, CD R3C 4M6
(204) 949-0811; FAX (204) 956-0848
Shiela Braidek

**ONTARIO**
Occupational Health Clinics for Ontario Workers
15 Gervais Drive, Suite 308
Toronto ON, Canada M3C 1Y8
(416) 449-0009; FAX (416) 449-7772
Andrew King, Executive Director

Occupational Health Clinics for Ontario Workers
848 Main Street East
Hamilton ON, Canada L8M 1L9
(905) 549-2552; FAX (905) 549-7993
Chuck Emberson, Executive Director

Occupational Health Clinics for Ontario Workers
1780 Regent Street South
Times Square Mall
Sudbury ON, Canada P3C 3Z8
(705) 523-2330; FAX (705) 522-8957
Donna Campbell, Executive Director

**ONTARIO (continued)**
Occupational Health Clinics for Ontario Workers
547 Victoria Ave.
Windsor ON, Canada N9A 4N1
(519) 973-4800; FAX (519) 973-1906
Jim Brophy, Executive Director

Occupational Health Clinics for Ontario Workers
171 Kendall St.
Point Edward ON, Canada N7V 4G6
(519) 337-4627;
Jim Brophy, Executive Director

**PEDIATRIC ENVIRONMENTAL HEALTH SPECIALITY UNITS**

**CALIFORNIA**
The University California-San Francisco/ University of California-Irvine Pediatric Environmental Health Speciality Unit
Contact: (415) 206-4320*
*Contact for both sites-San Francisco and Irvine*

**GEORGIA**
The Southeast Pediatric Environmental Health Speciality Unit
Emory University
Atlanta GA
(877) 33PEHSU (877-337-3478)

**ILLINOIS**
Pediatric Environmental Health Center
Cook County Hospital
Chicago IL
(312) 633-5310

**MASSACHUSETTS**
Pediatric Environmental Health Center at Children's Hospital
Occupational and Environmental Health Center at Cambridge Hospital
Boston MA
(888) CHILD14 (888-244-5314)

**NEW YORK**
Mt. Sinai Pediatric Environmental Health Unit
Mt. Sinai-Irving J Selikoff Center for Occupational and Environmental Medicine
New York NY
(212) 241-6173

**WASHINGTON**
Children's Environmental Health Center
University of Washington Occupational and Environmental Medicine Program
Seattle WA
(877) KID-CHEM (877-543-2463)

**ALBERTA**
Pediatric Environmental Health Clinic
Misericordia Child Health Centr
Edmonton AB
(780) 930-5794

# *Appendix III*

## *State Health Departments*

**State Health Departments**

Alabama Department of Public Health
The RSA Tower, Suite 1552
201 Monroe Street
Montgomery, AL 36130
(334) 206-5200

Alaska Department of Health and Social Services
Alaska Office Building
PO Box 110610
Juneau, AK 99811-0610
(907) 465-3090

American Samoa Department of Health
Government of American Samoa
LBJ Tropical Medical Center
Pago Pago AS 96799
011-684-6334606

Arizona Department of Health Services
1740 W. Adams Street, Room 407
Phoenix, AZ 85007
(602) 542-1025

Arkansas Department of Health
4815 W. Markham Street
Little Rock, AR 72205-3867
(501) 661-2417

California Department of Health Services
714 P Street
Sacramento, CA 95814
(916) 657-1431

Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, CO 80246
(303) 692-2011

Connecticut Department of Public Health
410 Capitol Avenue
Hartford, CT 06134
(860) 509-7101

Delaware Division of Public Health
Jesse Cooper Bldg.
PO Box 637
Dover, DE 19903
(302) 739-4700

District of Columbia Department of Health
825 North Capitol St., NW, Suite 4400
Washington, DC 20002
(202) 442-5999

Florida Department of Health
2585 Merchants Row Blvd., Suite 140
Tallahassee, FL 32399
(850) 245-4321

Georgia Department of Human Resources
2 Peachtree Street NW, Suite 15-470
Atlanta, GA 30303
(404) 657-2700

Guam Department of Public Health and Social Services
PO Box 2816
Agana, GU 96910
011-671-7357102

Hawaii Department of Health
1250 Punchbowl Street
PO Box 3378
Honolulu, HI 96813
(808) 586-4410

Idaho Department of Health and Welfare
450 W. State Street, Box 83720
Boise, ID 83720
(208) 334-5945

Illinois Department of Public Health
535 W. Jefferson Street
Springfield, IL 62761
(217) 782-4977

Indiana Department
2 North Meridan
Indianapolis, IN 46204
(317) 233-7400

Iowa Department of Public Health
Lucas State Office Bldg.
312 E. 12th Street
Des Moines, IA 50319
(515) 281-5605

Kansas Department of Health and Environment
900 SW Jackson, 6th Floor
Topeka, KS 66612
(785) 296-1086

Kentucky Department for Health Services
275 E. Main Street
Frankfort, KY 40621
(502) 564-3970

Louisiana Department of Health and Hospitals
PO Box 3214
Baton Rouge, LA 70821
(225) 342-8093

Maine Bureau of Health
Department of Human Services
State House Station #11
Augusta, ME 04333
(207) 287-8016

Maryland Department of Health and Mental Hygiene
201 W. Preston Street, Suite 500
Baltimore, MD 21201
(410) 767-6505

Massachusetts Department of Public Health
250 Washington Street, 2nd Floor
Boston, MA 02108
(617) 624-5200

Michigan Department of Community Health
3423 N. Martin Luther King, Jr. Blvd
PO Box 30195
Lansing, Ml 48909
(517) 335-8024

Micronesia Government of the Federal States of Micronesia
P.O. Box PS 70, Palikir Stn
Pohnpei FM 96941
011-691-3202619

Minnesota Department of Health
85 East 7th Place, Suite 400
St. Paul, MN 55101
(651) 251-5813

Mississippi State Department of Health
PO Box 1700
2423 N. State Street
Jackson, MS 39215
(601) 960-7634

Missouri Department of Health
920 Wildwood Drive
Jefferson City, MO 65102
(573) 751-6002

Montana Department of Health and Human Services
111 North Sanders, 3rd Floor
Helena, MT 59604
(406) 444-5622

North Mariana Islands
Department of Public Health
P.O. Box 409, CK
Saipan MP 96950
(670) 234-8950

Nebraska Department of Regulation and Licensure
PO Box 95007
Lincoln, NE 68509
(402) 471-8566

Nevada State Health Division
Nevada Department of Human Resources
505 E. King Street, Room 201
Carson City, NV 89701
(775) 684-4200

New Hampshire Department of Health and Human Services
6 Hazen Drive
Concord, NH 03301
(603) 271-8560

New Jersey Department of Health and Senior Services
PO Box 360, Room 805
Trenton, NJ 08625
(609) 292-7837

New Mexico Health
1190 St. Francis Drive
Santa Fe, NM 87502
(505) 827-2613

New York Department of Health
Corning Tower Building, 14th Floor
Empire State Plaza
Albany, NY 12237
(518) 474-2011

North Carolina Department of Environment,

Health and Natural Resources
Division of Health Services
101 Blair Drive
Adams Building
Raleigh, NC 27626
(919) 733-4392

North Dakota Department of Health
600 E. Boulevard Avenue
Bismark, ND 58505-0200
(701) 328-2372

Ohio Department of Health
246 N. High Street
PO Box 118
Columbus, OH 43266-0588
(614) 466-2253

Oklahoma State Department of Health
1000 NE 10th Street
Oklahoma City, OK 73117
(405) 271-4200

Oregon Department of Human Services
800 NE Oregon Street, #21
Portland, OR 97232
(503) 731-4000

Pennsylvania Department of Health
PO Box 90, Room 802.
Harrisburg, PA 17108
(717) 787-6436

Puerto Rico Department of Health
PO Box 70184
San Juan, PR 00936
(787) 274-7600

Rhode Island Department of Health
3 Capitol Hill
Providence, RI 02908
(401) 222-2231

South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201
(803) 898-3300

South Dakota State Department of Health
600 East Capitol
c/o 500 East Capitol
Pierre, SD 57501
(605) 773-3361

Tennessee Department of Health
3rd Floor, Cordell Hull Bldg.
425 5th Avenue N
Nashville, TN 37247-0101
(615) 741-3111

Texas Department of Health
1100 W. 49th Street
Austin, TX 78756
(512) 458-7376

Utah Department of Health
288 North 1460 West
PO Box 142802
Salt Lake City, UT 84114
(801) 538-6111

Vermont Department of Health
PO Box 70
Burlington, VT 05402
(802) 863-7280

Virgin Islands Social and Health Services
48 Sugar Estate
St. Thomas, VI 00802
(340) 774-0117

Virginia Department of Health
1500 East Main Street
PO Box 2448
Richmond, VA 23219
(804) 786-3561

Washington State Department of Health
1112SE Quince Street, Mail Stop 7890
Olympia, WA 98504-7890
(360) 236-4015

West Virginia Department of Health and Human Services
1900 Kanawha Blvd., Bldg. 3, Room 518
Charleston, WV 25305
(304) 558-2971

Wisconsin Division of Health
PO Box 309
Madison, WI 53701-0309
(608) 266-1511

Wyoming Department of Health
117 Hathaway Bldg.
Cheyenne, WY 82002
(307) 777-7656

# *Appendix IV*

## *Consultation Resources*

# Consultation Resources

**American College of Occupational and Environmental Medicine**
114 N. Arlington Heights Road
Arlington Heights, IL 60004
(847) 818-1800

**American Board of Medical Toxicology**
Heather Miller, Executive Director
777 E. Park Drive
PO Box 8820
Harrisburg PA 17105-8820
(717) 558-7846

**Association of Occupational and Environmental Clinics**
Katherine Kirkland, Executive Director
1010 Vermont Avenue
Suite 513
Washington, DC 20005
(202) 347-4976

The Association of Occupational and Environmental Clinics (AOEC) is a network of clinics affiliated with medical schools throughout the U.S. Member clinics provide professional training, community education about toxic substances, exposure and risk assessment, clinical evaluations, and consultation. A lending library of training materials is maintained for use by members. Membership is open to any person who shares the goals of the Association. Clinicians can contact the AOEC office for referrals.

**Teratogen Exposure Registry and Surveillance (TERAS)**
Frederick Bieber, Ph.D.
Department of Pathology
Brigham and Women's Hospital
75 Francis Street
Boston, MA 02115
(617) 732-6507

TERAS is a network of geneticists and pathologists studying human embryos and fetuses exposed to teratogens. TERAS maintains information networks for consultation and evaluations.

**University programs in occupational health, industrial hygiene, or toxicology**
Schools of public health or schools of medicine at universities function as resources to local communities. In addition, some hospitals have occupational or environmental health clinics that accept referrals.

**MotherRisk Program**

Gideon Koren, M.D., Director
Hospital for Sick Children
555 University Avenue
Toronto, Ontario M5G IX8
(416) 813-6780

The MotherRisk Program will counsel callers about t he safety of an exposure to drugs, chemicals, or radiation during pregnancy or breast feeding. The team of physicians and information specialists give advice on whether medications, X-rays, or chemicals in the work environment will harm the developing fetus or breast-fed baby. Genetic counseling is available from the Hospital for Sick Children's Genetic Department.

# State/Federal/National Resources

**Chemical Emergencies**

National Response Center
(800) 424-8802
http://nrc.uscg.mil/index.htm

**Hazardous Waste**

Emergency Planning and Community Right-To-Know Hotline (EPA)
Developing chemical contingency plans, gathering site-specific information, list of more than 400 acutely toxic chemicals
(800) 535-0202
http://www.epa.gov/epaoswer/hotline/index.htm

Superfund Order and Information Line
Provides information about Superfund Records of Decision-hazardous waste sites to be cleaned up, actions being taken
(800) 775-5037
http://www.epa.gov/superfund/sites/phonefax/index.htm

Integrated Risk Information System (IRIS)
Hazardous chemicals information, including health effects
(513) 569-7254
http://www.epa.gov/iris/

IRIS User Support
(513) 569-7254

**Lung Disease**

Lungline/National Jewish Hospital
Information on lung disease from chemical exposure
(800) 222-5864
http://www.NationalJewish.org

**Lead**

National Center for Environmental Health and Injury Control (CDC)
Lead poisoning prevention
(404) 488-4880
http://www.cdc.gov

Child and Maternal Health Clearinghouse
Publications on lead poisoning
(888) 434-4MCH
http://www.nmchc.org/

**Occupational Health**

NIOSH
Information and publications on health effects of occupational exposures
(800) 356-4674
http://www.cdc.gov.niosh/homepage.html
Medical Section/Diagnosis and Treatment
(513) 841-4388
Industrial Hygiene
(513) 841-4374

OSHA (Occupational Safety and Health Administration)
Regulations for toxic and hazardous substances in the workplace
For emergencies: (800) 321-6742
For other inquires: (202) 693-1999
http://www.osha.gov

**Pesticides**

National Pesticide Hotline
(800) 858-7378
http://www.growinglifestyle.com/article/73p5/a1656.html

National Pesticide Telecommunications Network
(800) 858-7378
http://ace.orst.edu/info/nptn/

National Pesticide Information Retrieval System (NPIRS)
Help number for searching NPIRS database to get fact sheets on pesticides, insecticides, fungicides, state and federally registered chemicals. Funded by EPA/USDA, managed by Purdue University
(765) 494-6616
http://ceris.purdue.edu/npirs/npirs.html

**Radon**

Radon Hotline
(800) SOS-RADON
http://www.epa.gov/iaq/radon/index.html

EPA Radon Information Center
(800) 438-4318
http://www.epa.gov/iaq/iaqinfo.html

**Toxic Substances**

Toxicology Information Response Center (Oak Ridge)
General toxics information, searches on chemicals
(865) 576-1746
http://www.ornl.gov/TechResources/tirc/hmepg.html

Agency for Toxic Substances and Disease Registry (ATSDR)
Emergency Response Section. Rapid assistance provided about health issues from chemical exposures.
(404) 639-0615 (24 hours)
(404) 639-6360 (24 hours)
(404) 639-6363 (fax)
http://www.atsdr.cdc.gov/

Toxic Substances Control Act (TSCA) Hotline/Public Information Office (EPA)
Answers questions and gives general technical assistance on TSCA. Guidance on TSCA regulations
(202) 554-1404
Http://es.epa.gov/oeca/ccsmd/tsca.html

Toxic Chemical Release Inventory System (EPA)
Information about which chemicals are used, stored, released by companies
(800) 535-0202
http://toxnet.nlm.nih.gov

CHEMTREC (Chemical Manufacturers Association)
Nonemergency health and safety information on chemicals
(800) 282-8200
http://memberexchange.cmahq.com/chemtrec.nsf

**Water**

EPA Safe Drinking Water Hotline
(800) 426-4791
www.epa.gov.safewater

# *Chemical Glossary*

| *Chemical Formula* | *Structural Formula* | *Chemical Name* |
|---|---|---|
| $AsH_3$ | $AsH_3$ | Arsine |
| $As_2O_3$ | $As_2O_3$ | Arsenic trioxide |
| $CHCl_2NO$ | $ClC[NOH]Cl$ | Phosgene oxime |
| $CHN$ | $HCN$ | Hydrogen cyanide |
| $CH_2Cl_2$ | $CH_2Cl_2$ | Methylene chloride |
| $CH_2O$ | $HCHO$ | Formaldehyde |
| $CH_3Br$ | $CH_3Br$ | Methyl bromide |
| $C_2Cl_4$ | $Cl_2CCCl_2$ | Tetrachloroethylene |
| $C_2HCl_3$ | $ClCHCCl_2$ | Trichloroethylene |
| $C_2H_3Cl$ | $CH_2CHCl$ | Vinyl chloride |
| $C_2H_3Cl_3$ | $CH_3CCl_3$ | 1,1,1-Trichloroethane |
| $C_2H_4O$ | $[CH_2]_2O$ | Ethylene oxide |
| $C_2H_6O_2$ | $HO[CH_2]_2OH$ | Ethylene glycol |
| $C_3H_3N$ | $CH_2CHCN$ | Acrylonitrile |
| $C_4H_6$ | $CH_2[CH]_2CH_2$ | 1,3-Butadiene |
| $C_6H_6$ | $C_6H_6$ | Benzene |
| $C_6H_6O$ | $C_6H_5$-OH | Phenol |
| $C_6H_7N$ | $C_6H_5NH_2$ | Aniline |
| $C_7H_8$ | $C_6H_5$-$CH_3$ | Toluene |
| $C_8H_{10}$ | $CH_3$-$C_6H_4$-$CH_3$ | Xylene |
| $C_9H_6N_2O_2$ | $CH_3C_6H_3[NCO]_2$ | Toluene diisocyanate |
| $C_{10}H_6Cl_8$ | $C_{10}H_6Cl_8$ | Chlordane |
| $C_{10}H_{14}NO_5PS$ | $[C_2H_5O]_2P[S]OC_6H_4NO_2$ | Parathion |
| $COCl_2$ | $COCl_2$ | Phosgene |
| $Cl_2$ | $Cl_2$ | Chlorine |
| $HCl$ | $HCl$ | Hydrogen chloride |
| $HF$ | $HF$ | Hydrogen fluoride |
| $Hg$ | $Hg$ | Mercury |
| $H_2O_2$ | $H_2O_2$ | Hydrogen peroxide |
| $H_2S$ | $H_2S$ | Hydrogen sulfide |
| $NH_3$ | $NH_3$ | Ammonia |
| $NO_x$ | $NO_x$ | Nitrogen oxides |
| $PH_3$ | $PH_3$ | Phosphine |
| $NaOH$ | $NaOH$ | Sodium hydroxide |
| $SO_2$ | $O_2S$ | Sulfur dioxide |

# *Chemical Index*

Listed below are names of chemical protocols and their synonyms. Subjects of chemical protocols are in boldface italics (e.g., ***Arsine***)

**Acetylene trichloride** *See* Trichloroethylene
***Acrylonitrile***
**Alkron** *See* Parathion
**Alleron** *See* Parathion
**Aminobenzene** *See* Aniline
**Aminophen** *See* Aniline
***Ammonia***
**Ammonia gas** *See* Ammonia
**Ammonia solution** *See* Ammonia
**Ammonium hydroxide** *See* Ammonia
**Amprolenne** *See* Methylene oxide
**AN** *See* Acrylonitrile
**Anammonide** *See* Hydrogen cyanide
**Anhydrous ammonia** *See* Ammonia
***Aniline***
**Aqueous ammonia** *See* Ammonia
**Arsenic hydride** *See* Arsine
**Arsenic trihydride** *See* Arsine
***Arsenic trioxide***
**Arseniuretted hydrogen** *See* Arsine
**Arsenous acid** *See* Arsenic trioxide
**Arsenous oxide** *See* Arsenic trioxide
**Arsenous hydride** *See* Arsine
***Arsine***
**Arylamine** *See* Aniline
***Benzene***
**Benzenamine** *See* Aniline
**Benzenol** *See* Phenol
**Benzol** *See* Benzene
**Bis(beta-chloroethyl) sulfide** *See* Blister agent (H, HD, HT)
**Bis(2-chloroethyl) sulfide** *See* Blister agent (H, HD, HT)
**Bis(2-chloroethyl)ethylamine** *See* Blister agent (HN1, HN2, HN3)
**Bis(2-chloroethyl)methylamine** *See* Blister agent (HN1, HN2, HN3)
***Blister Agent (H, HD, HT)***
***Blister Agent (HN1, HN2, HN3)***
***Blister Agent (HL, L)***
**Bromoethane** *See* Methyl bromide
***1,3-Butadiene***
**Bivinyl** *See* 1,3-Butadiene
**C-100** *See* Chlordane
**Carbolic acid** *See* Phenol
**Carbon oxychloride** *See* Phosgene
**Carbonic acid dichloride** *See* Phosgene
**Carbonic dichloride** *See* Phosgene
**Carbonyl chloride** *See* Phosgene
**Caustic soda** *See* Sodium hydroxide
**Caryolysin** *See* Blister agent (HN1, HN2, HN3)
**CD-68** *See* Chlordane
**Chlordan** *See* Chlordane
***Chlordane***
***Chlorine***
**Chlor-Kil** *See* Chlordane
**Chlormethine** *See* Blister agent (HN1, HN2, HN3)
**1-Chloro-2(beta-chloroethylthio)ethane** *See* Blister agent (H, HD, HT)
**2-Chloro-N-(2-chloroethyl)-N-ethylethanamine** *See* Blister agent (HN1, HN2, HN3)
**Chloroethene** *See* 1,1,1-Trichloroethane
**Chloroethylene** *See* vinyl chloride
**Chloroformyl chloride** *See* Phosgene
**Chlorohydric acid** *See* Hydrogen chloride
**2-Chloro-N,N-bis(2-chloroethyl)ethanamine** *See* Blister agent (HN1, HN2, HN3)
**Coal tar naptha** *See* Benzene
**CX** *See* Phosgene oxime
**Cyanocthylene** *See* Acrylonitrile
**Cyclohexatriene** *See* Benzene
**Danthion** *See* Parathion
**2,2'-Dichloroethyl sulfide** *See* Blister agent (H, HD, HT)
**Di-2-chloroethyl sulfide** *See* Blister agent (H, HD, HT)
**Dichloromethane** *See* Methylene chloride
**2,2'-Dichloro-N-methyldiethylamine** *See* Blister agent (HN1, HN2, HN3)
**Dichloren** *See* Blister agent (HN1, HN2, HN3)
**Dichloroformoxime** *See* Phosgene oxime.
**2,2'-Dichlorotriethylamine** *See* Blister agent (HN1, HN2, HN3)
**Dihydrogen dioxide** *See* Hydrogen peroxide
**Dihydrogen sulfide** *See* Hydrogen sulfide
**Diisocyanatotoluene** *See* Toluene diisocyanate
**Dimethylbenzene** *See* Xylene
**Dimethylene oxide** *See* Ethylene oxide
**Dinitrogen tetroxide** *See* Nitrogen oxides
**DNTP** *See* Parathion

**DPP** *See* Parathion
**E-605** *See* Parathion
**Epoxyethane** *See* Ethylene oxide
**1,2-Ethanediol** *See* Ethylene glycol
**Ethyl-S** *See* Blister agent (HN1, HN2, HN3)
**Ethylbis(2-chloroethyl)amine** *See* Blister agent (HN1, HN2, HN3)
**Ethyl parathion** *See* Parathion
***Ethylene glycol***
***Ethylene oxide***
**Ethylene tetrachloride** *See* Tetrachloroethylene
**Ethylene trichloride** *See* Trichloroethylene
**Ethinyl trichloride** *See* Trichloroethylene
**Etilon** *See* Parathion
**ETO** *See* Ethylene oxide
**Fluoric acid** *See* Hydrogen fluoride
**Fluorine monohydride** *See* Hydrogen fluoride
***Formaldehyde***
**Formalin** *See* Formaldehyde
**Formic aldehyde** *See* Formaldehyde
**Formonitrile** *See* Hydrogen cyanide
***Gasoline***
**Gas** *See* Gasoline
**HL** *See* Blister agent (HL, L)
**HN1** *See* Blister agent (HN1, HN2, HN3)
**HN2** *See* Blister agent (HN1, HN2, HN3)
**HN3** *See* Blister agent (HN1, HN2, HN3)
**Hydrochloric acid** *See* Hydrogen chloride
**Hydrocyanic acid** *See* Hydrogen cyanide
**Hydrofluoric acid** *See* Hydrogen fluoride
**Hydrofluride** *See* Hydrogen fluoride
**Hydrogen arsenide** *See* Arsine
***Hydrogen chloride***
***Hydrogen cyanide***
**Hydrogen dioxide** *See* Hydrogen peroxide
***Hydrogen fluoride***
***Hydrogen peroxide***
**Hydrogen phosphide** *See* Phosphine
***Hydrogen sulfide***
**Hydroperoxide** *See* Hydrogen peroxide
**Hydroxybenzene** *See* Phenol
**Iprit** *See* Blister agent (H, HD, HT)
**Iscobrome** *See* Methyl bromide
**Kampstoff "Lost"** *See* Blister agent (H, HD, HT)
**L** *See* Blister agent (HL, L)
**Lewisite** *See* Blister agent (HL, L)
**Liquid ammonia** *See* Ammonia
**Lye** *See* Sodium hydroxide
**MBA** *See* Blister agent (HN1, HN2, HN3)
**Mechlorethamine** *See* Blister agent (HN1, HN2, HN3)
***Mercury***
**Methanal** *See* Formaldehyde
**Methane dichloride** *See* Methylene chloride
**Methyl aldehyde** *See* Formaldehyde
**Methyl benzene** *See* Toluene
**Methyl benzol** *See* Toluene
***Methyl bromide***
**Methylchloroform** *See* 1,1,1-Trichloroethane
**Methyl toluene** *See* Xylene
**Methylene bichloride** *See* Methylene chloride
***Methylene chloride***
**Methylene dichloride** *See* Methylene chloride
**Methylene oxide** *See* Formaldehyde
**Mixed xylenes** *See* Xylene
**Molecular chlorine** *See* Chlorine
**Monobromomethane** *See* Methyl bromide
**Monohydride** *See* Hydrogen fluoride
**Monohydroxybenzene** *See* Phenol
**Mononitrogen monoxide** *See* Nitrogen oxides
**Monophenol** *See* Phenol
**Motor fuel** *See* Gasoline
**Muriatic acid** *See* Hydrogen chloride
**Mustard gas** *See* Blister agent (H, HD, HT)
**Mustard-Lewisite** *See* Blister agent (HL, L)
**Mustine** *See* Blister agent (HN1, HN2, HN3)
***Nerve agent (GA, GB, GD, VX)***
**Nitric oxide** *See* Nitrogen oxides
**Nitrogen dioxide** *See* Nitrogen oxides
**Nitrogen monoxide** *See* Nitrogen oxides
**Nitrogen peroxide** *See* Nitrogen oxides
**Nitrogen tetroxide** *See* Nitrogen oxides

**NTO** *See* Nitrogen oxides
**Nitrogen fumes** *See* Nitrogen oxides
**Nitrous fumes** *See* Nitrogen oxides
***Nitrogen oxides***
**Octachlor** *See* Chlordane
**Oxirane** *See* Ethylene oxide
**Oxacyclopropane** *See* Ethylene oxide
**Oxomethane** *See* Formaldehyde
**Paraform** *See* Formaldehyde
***Parathion***
**Perc** *See* Tetrachloroethylene
**Perchloroethylene** *See* Tetrachloroethylene
**Peroxide** *See* Hydrogen peroxide
**Petrol** *See* Gasoline
**Phenic acid** *See* Phenol
***Phenol***
**Phenyl alcohol** *See* Phenol
**Phenyl hydroxide** *See* Phenol
**Phenylic acid** *See* Phenol
**Phenylic alcohol** *See* Phenol
**Peroxide** *See* Hydrogen peroxide
**Phenyl hydride** *See* Benzene
**Phenylamine** *See* Aniline
**Phenylmethane** *See* Toluene
***Phosgene***
***Phosgene oxime***
***Phosphine***
**Phosphorus hydride** *See* Phosphine
**Phosphorus trihydride** *See* Phosphine
**Phosphoretted hydrogen** *See* Phosphine
**Propenenitrile** *See* Acrylonitrile
**Prussic acid** *See* Hydrogen cyanide
**Pyrrolyene** *See* 1,3-Butadiene
**Quick silver** *See* Mercury
**Sarin** *See* Nerve agent (GA, GB, GD, VX)
**Senfgas** *See* Blister agent (H, HD, HT)
**Sewer gas** *See* Hydrogen sulfide
**Soda lye** *See* Sodium hydroxide
**Sodium hydrate** *See* Sodium hydroxide
***Sodium hydroxide***
**Soman** *See* Nerve agent (GA, GB, GD, VX)
**Spirits of salt** *See* Hydrogen chloride
**S-yperite** *See* Blister agent (H, HD, HT)
**Stathion** *See* Parathion
**Stink damp** *See* Hydrogen sulfide
***Sulfur dioxide***
**Sulfur hydride** *See* Hydrogen sulfide
**Sulfur mustard agent H** *See* Blister agent (H, HD, HT)
**Sulfur mustard agent HD** *See* Blister agent (H, HD, HT)
**Sulfur mustard agent HT** *See* Blister agent (H, HD, HT)
**Sulfur mustards** *See* Blister agent (H, HD, HT)
**Sulphos** *See* Parathion
**Sulfuretted hydrogen** *See* Hydrogen sulfide
**Sulfur mustard/lewisite** *See* Blister agent (HL, L)
**Sulfurous anhydride** *See* Sulfur dioxide
**Sulfurous oxide** *See* Sulfur dioxide
**TCE** *See* Trichloroethylene
**TDI** *See* Toluene diisocyanate
**Tabun** *See* Nerve agent (GA, GB, GD, VX)
**Termicide C-100** *See* Chlordane
***Tetrachloroethylene***
**Thiophos** *See* Parathion
***Toluene***
***Toluene diisocyanate***
**Toluol** *See* Toluene
**Tolylene diisocyanate** *See* Toluene diisocyanate
**Topichlor** *See* Chlotdane
**Toxichlor** *See* Chlordane
**Tri** *See* Trichloroethylene
***1,1,1-Trichloroethane***
**Trichloroethene** *See* Trichloroethylene
***Trichloroethylene***
**2,2',2"-Trichlorotriethylamine** *See* Blister agent (HN1, HN2, HN3)
**Tris(2-chloroethyl)amine** *See* Blister agent (HN1, HN2, HN3)
**VCN** *See* Actylonittile
**Velsicol 1068** *See* Chlordane
**Vinyl ethylene** *See* 1,3-Butadiene
***Vinyl chloride***
**Vinyl cyanide** *See* Acrylonitrile
**VX** *See* Nerve agent (GA, GB, GD, VX)
**White arsenic** *See* Arsenic trioxide
***Xylene***
**Xylol** *See* Xylene
**Yellow cross liquid** *See* Blister agent (H, HD, HT)
**Yperite** *See* Blister agent (H, HD, HT)

**Absorption**. The incorporation of liquids or gases into the body. Absorption is also the process by which liquid hazardous materials are soaked up by sand, sawdust, or other material to limit the spread of contamination.

**Acute effect**. A pathologic process caused by a single substantial exposure.

**Acute exposure**. A single encounter to toxic concentrations of a hazardous material or multiple encounters over a short period of time (usually 24 hours).

**Adaptation**. The tendency of certain receptors to become less responsive or cease to respond to repeated or continued stimuli.

**Adsorption**. The property of a substance to attract and hold to its surface a gas, liquid, or other substance.

**Air purification devices**. Respirators or filtration devices that remove particulate matter, gases, or vapors from the atmosphere. These devices range from full-facepiece, dual-cartridge respirators with eye protection to half-mask, facepiece-mounted cartridges with no eye protection.

**Air-supplied respirators**. A device that provides the user with compressed air for breathing.

**Airways**. Any parts of the respiratory tract through which air passes during breathing.

**Albuminuria**. The presence of protein (primarily albumin) in the urine; usually indicative of transient dysfunction or disease.

**Alkali**. A basic substance (pH greater than 7) that has the capacity to neutralize an acid and form a salt.

**Alveolar ducts**. The smallest of the lungs' airways that connect terminal bronchioles and alveolar sacs. Sometimes called bronchioles.

**Alveoli** (singular alveolus). Microscopic air sacs in which gas exchange between the blood and the lungs occurs.

**Anemia**. Any condition in which the number of red blood cells, the amount of hemoglobin, and the volume of packed red blood cells per 100 milliliters of blood are less than normal.

**Anhydrous**. Containing no water.

**Anisocytosis**. Considerable variation in the size of blood cells.

**Anorexia**. Lack of appetite; aversion to food.

**Anoxia**. Lack of oxygen in inspired air, blood, or tissues.

**Anterior chamber of the eye**. The fluid-filled front portion of the eye between the cornea and the lens.

**Antidote**. An agent that neutralizes a poison or counteracts its effects.

**Anuria**. Absence of urine production.

**Aplastic anemia**. A condition characterized by a decrease in the amount of hemoglobin in the blood due to incomplete or defective development of red blood cells; usually accompanied by defective regeneration of white blood cells and platelets.

**Apnea**. Cessation of breathing.

**Asphyxia**. A condition in which the exchange of oxygen and carbon dioxide in the lungs is absent or impaired.

**Aspiration pneumonia**. Inflammation of the lungs due to inhalation of foreign material, usually food or vomitus, into the bronchi.

**Asthma**. A chronic condition in which constriction (spasm) of the bronchial tubes occurs in response to irritation, allergy, or other stimuli.

**Ataxia**. Incoordination of voluntary movement, especially affecting gait and speech.

**Atelectasis**. Lung collapse.

**Atomic weight**. The average weight (or mass) of all the isotopes of an element, as determined from the proportions in which they are present in a given element, compared with the mass of the 12 isotope of carbon (taken as precisely 12.000), which is the official international standard; measured in daltons.

**Atopy**. A tendency or predisposition to allergic reactions.

**Autoignition temperature**. The lowest temperature at which a gas or vapor-air mixture will ignite from its own heat source or a contacted heated surface without a spark or flame.

**Axon**. The part of a nerve cell that conducts nervous impulses away from the nerve cell body to the remainder of the cell (i.e., dendrites); large number of fibrils enveloped by a segmented myelin sheath.

**Axonal**. Pertaining to an axon.

**Bilirubin**. A red pigment that results from normal and abnormal destruction of red blood cells.

**Blepharospasm**. Involuntary spasmodic blinking or closing of the eyelids due to severe irritation.

**Boiling point**. The temperature at which the vapor pressure of a liquid equals the atmospheric pressure and the liquid becomes vapor.

**Bradycardia**. Slow heart rate, usually under 60 beats per minute.

**Bronchi** (singular **bronchus**). Large divisions of the trachea that convey air to and from the lungs.

**Bronchiole**. A small-diameter airway branching from a bronchus.

**Bronchitis**. Inflammation of the mucous membrane of the bronchial tubes, usually associated with a persistent cough and sputum production.

**Bronchorrhea**. Increased bronchial secretions.

**Bronchospasm**. Contraction of the smooth muscle of the bronchi, causing narrowing of the bronchi. This narrowing increases the resistance of air flow into the lungs and may cause a shortness of breath, typically associated with wheezing.

**Bullae**. Large fluid-filled blisters.

**Carcinogenic**. Causing cancer.

**Cardiac dysrhythmia**. Abnormality in the rate, regularity, or sequence of the heart beat. Formerly referred to as cardiac arrhythmia.

**Cataract**. Loss of transparency (clouding) of the lens of the eye.

**Catecholamines**. Substances of a specific chemical nature (pyrocatechols with an alkylamine side chain). Catecholamines of biochemical interest am those produced by the nervous system (e.g., epinephrine [adrenaline] or dopamine) to increase heart rate and blood pressure, or medicines with the same general chemical structure and effect.

**Caustic**. Substance that strongly irritates, bums, corrodes, or destroys living tissue.

**Cerebellar abnormalities**. Any irregularity in the cerebellum of the brain.

**Cerebellum**. The large brain mass located at the posterior base of the brain, responsible for balance and coordination of movement.

**Cerebral infarctions**. Death of tissue in the cerebrum due to lack of blood flow to the area.
Cerebrum. The largest portion of the brain; includes the cerebral hemispheres (cerebral cortex and basal ganglia).

**Chemexfoliation**. Chemical skin peeling; use of chemicals to remove scars or pigmentation defects.

**Chemical formula**. The collection of atomic symbols and numbers that indicates the chemical composition of a pure substance.

**Chemical-protective clothing**. Clothing specifically designed to protect the skin and eyes from direct chemical contact. Descriptions of chemical-protective apparel include nonencapsulating and encapsulating (referred to as liquid-splash protective clothing and vapor-protective clothing, respectively).

**Chronic effect**. A pathologic process caused by repeated exposures over a period of long duration.

**Chronic exposure**. Repeated encounters with a hazardous substance over a period of long duration.

**Cognitive function**. The ability to think.

**Coma**. State of profound unconsciousness from which the patient cannot be aroused.

**Combustible liquid**. Any liquid that has a flash point at or above 100 °F (37.7 °C) and below 200 °F (93.3 °C).

**Compressed gas**. Gas whose volume has been reduced by pressure.

**Congenital anomalies**. Birth defects.

**Conjunctiva** (*plural* **conjuctivae**). The delicate mucous membrane that covers the exposed surface of the eyeball and lines the eyelids.

**Conjunctivitis**. Inflammation of the conjunctiva; can result in redness, irritation, and tearing of the eye.

**Contact dermatitis (allergic)**. A delayed-onset skin reaction caused by skin contact with a chemical to which the individual has been previously sensitized.

**Contact dermatitis (irritant)**. Inflammatory skin reaction caused by a skin irritant.

**Control zones**. Areas at a hazardous materials incident whose boundaries are based on safety and the degree of hazard; generally includes the Hot Zone, Decontamination Zone, and Support Zone.

**Cornea**. Transparent membrane that covers the colored part of the eye.

**Cornea1 opacification**. Clouding of the cornea.

**Corrosive**. Ability to destroy the texture or substance of a tissue.

**Critical Care Area**. That area in a hospital designated for the treatment of severely ill patients.

**Cyanosis**. Bluish discoloration of the skin and mucous membranes due to deficient oxygenation of the blood; usually evident when reduced hemoglobin (i.e., hemoglobin unable to carry oxygen) exceeds 5%.

**Decontamination**. The process of removing hazardous materials from exposed persons and equipment at a hazardous materials incident.

**Decontamination Zone**. The area surrounding a chemical hazard incident (between the Hot Zone and the Support Zone) in which contaminants are removed from exposed victims.

**Defat**. To remove natural oils from the skin.

**Degradation**. The process of decomposition. When applied to protective clothing, a molecular breakdown of material because of chemical contact; degradation is evidenced by visible signs such as charring, shrinking, or dissolving. Testing clothing material for weight changes, thickness changes, and loss of tensile strength will also reveal degradation.

**Delirium**. A condition of extreme mental (and sometimes motor) excitement marked by defective perception, impaired memory, and a rapid succession of confused and unconnected ideas, often with illusions and hallucinations.

**Dementia**. A general deterioration of mental abilities.

**Demyelination**. Removal (destruction) of the myelin sheath that surrounds and protects nerves.

**Denervation atrophy**. Shrinkage or wasting of muscles due to loss of nerve supply.

**Dermal**. Relating to the skin.

**Dermatitis**. Skin inflammation.

**Dermis**. The layer of the skin just below the epidermis or outer layer. The dermis has a rich supply of blood vessels, nerves, and skin structures.

**Desiccation**. Removal of moisture; drying.

**Desiccant effect**. Drying of the skin caused by removal of soluble oils.

**Dilution**. The use of water to lower the concentration or amount of a contaminant.

**Diaphoresis**. Excessive perspiration.

**Diplopia**. Double vision.

**Dyscrasia**. Blood disorder.

**Dysphagia**. Difficulty in swallowing.

**Dyspnea**. Shortness of breath; difficult or labored breathing.

**Dysuria**. Painful or difficult urination.

**Edema**. Accumulation of fluid in body cells or tissues; usually identified as swelling.

**Embolization**. Obstruction of a blood vessel by a transported clot or other mass.

**Embryo**. In humans, the developing conceptus up to 8 weeks after fertilization of the egg. See also fetus.

**Embryotoxicity**. Ability to harm the embryo.

**Emergency**. A sudden and unexpected event requiring immediate remedial action.

**Emesis**. Vomiting.

**Encephalopathy**. Any disease of the brain.

**Environmental hazard**. A condition capable of posing an unreasonable risk to air, water, or soil quality, or plant or animal life.

**Epidermis**. The outermost layer of the skin.

**Erythroderma**. Intense, widespread reddening of the skin.

**Erythema**. Redness of the skin.

**Esophageal strictures**. Narrowing of the esophagus that causes difficulty in swallowing; often due to scar formation following extensive bums.

**Esophagus**. The portion of the digestive canal extending from the throat to the stomach. Also referred to as the gullet.

**Euphoria**. An intense and exaggerated feeling of well-being.

**Exfoliative dermatitis**. A skin condition that involves scaling or shedding of the superficial cells of the epidermis.

**Exothermic reaction**. Chemical reactions that produce heat.

**Explosives**. Compounds that are unstable and break down with the sudden release of large amounts of energy.

**Explosivity**. The characteristic of undergoing very rapid decomposition (or combustion) to release large amounts of energy,

**Fasciculation**. Muscle twitching.

**Fetotoxic**. Having the ability to harm the fetus.

**Fetus**. In humans, the conceptus from 8 weeks after fertilization until birth. See also embryo.

**Flame-resistant**. Slow or unable to bum.

**Flammable**. The ability of a substance to ignite and bum.

**Flammable (explosive) range**. The range of gas or vapor concentration (percentage by volume in air) that will bum or explode if an ignition source is present. Limiting concentrations are commonly called the lower explosive limit and upper explosive limit. Below the lower explosive limit, the mixture is too lean to bum; above the upper explosive limit, the mixture is too rich to bum.

**Flash point**. The minimum temperature at which a liquid produces enough vapor to ignite.

**Flashback**. The movement of a flame to a fuel source; typically occurs via the vapor of a highly volatile liquid or by a flammable gas escaping from a cylinder.

**Fluorosis**. Accumulation of excessive fluoride in the body; characterized by increased bone density and mineral deposits in tendons, ligaments, and muscles.

**Followup**. Constant or intermittent contact with a patient after diagnosis or therapy.

**Freezing point**. Temperature at which crystals start to form as a liquid is slowly cooled; alternatively, the temperature at which a solid substance begins to melt as it is slowly heated.

**Fume**. Fine particles (typically of a metal oxide) dispersed in air that may be formed in various ways (e.g., condensation of vapors, chemical reaction).

**Gangrene**. Death of tissue due to lack of blood supply.

**Gas**. A physical state of matter that has low density and viscosity, can expand and contract greatly in response to changes in temperature and pressure, readily and uniformly distributes itself throughout any container.

**Glaucoma**. A disease of the eye characterized by abnormal and damaging high pressure inside the eye; usually due to a blockage of the channel that normally allows the outflow of fluid from the eye.

**Glomerulus** (plural glomeruli). A tuft formed of capillary loops that filter blood in the kidney.

**Hazard**. A circumstance or condition that can cause harm.

**Hazardous materials**. Substances that, if not properly controlled, pose a risk to people, property, or the environment.

**Hazardous materials incident**. The uncontrolled release or potential release of a hazardous material from its container into the environment.

**Hematuria**. Condition in which the urine contains an abnormal amount of blood or red blood cells.

**Hemodialysis**. Removal of soluble substances from the blood by their diffusion through a semipermeable membrane.

**Hemoglobinuria**. Condition in which the urine contains an abnormal amount of hemoglobin.

**Hemolysis**. Destruction or dissolution of red blood cells in such a manner that hemoglobin is liberated into the medium in which the cells are suspended.

**Hemolytic anemia**. Any anemia resulting from destruction of red blood cells.

**Hemoptysis**. The spitting of blood derived from hemorrhage in the lungs or bronchial tubes.

**Hepatic**. Pertaining to the liver.

**Hepatomegaly**. Enlargement of the liver.

**Hot Zone**. The area immediately surrounding a chemical hazard incident, such as a spill, in which contamination or other danger exists.

**Hyperbilirubinemia**. A condition in which an abnormally large amount of bilirubin is found in the blood. Jaundice becomes apparent when the level of bilirubin is double the normal level.

**Hyperesthesia**. Increased sensitivity to touch, pain, or other sensory stimuli.

**Hyperpigmentation**. An excess of pigment in a tissue or part of the body.

**Hyperreflexia**. A condition in which the deep tendon reflexes are exaggerated.

**Hypersensitization**. Increased sensitivity of the immune system; induced by initial exposure with subsequent exposures eliciting a greater than expected immunologic response.

**Hypertension**. High blood pressure.

**Hypocalcemia**. A condition in which an abnormally low concentration of calcium ions is present in the blood.

**Hypokalemia**. A condition in which an abnormally low concentration of potassium ions is present in the blood.

**Hypomagnesemia**. A condition in which the plasma concentration of magnesium ions is abnormally low; may cause convulsions and concurrent hypocalcemia.

**Hypophosphatemia**. Condition in which an abnormally low concentration of phosphate is found in the blood.

**Hypotension**. Low arterial blood pressure.

**Hypotonia**. A condition in which there is a loss of muscle tone.

**Hypoxemia**. A condition in which inadequate oxygen is present in arterial blood, short of anoxia.

**Hypoxia**. Condition in which below-normal levels of oxygen are present in the air, blood, or body tissues, short of anoxia.

**Ignition (autoignition) temperature**. The minimum temperature required to ignite gas or vapor without a spark or flame being present.

**Immediately dangerous to life and health (IDLH)**. That atmospheric concentration of a chemical that poses an immediate danger to the life or health of a person who is exposed but from which that person could escape without any escape-impairing symptoms or irreversible health effects. A companion measurement to the permissible exposure limit (PEL), IDLH concentrations represent levels at which respiratory protection is required. IDLH is expressed in parts per million (ppm) or $mg/m^3$.

**Inadequate warning property**. Characteristic (e.g., odor, irritation) of a substance that is not sufficient to cause a person to notice exposure.

**Incident commander**. The person responsible for establishing and managing the overall operational plan at a hazardous material incident. The incident commander is responsible for developing an effective organizational structure, allocating resources, making appropriate assignments, managing information, and continually attempting to mitigate the incident.

**Insecticide**. An agent that has the ability to kill insects.

**Intention tremor**. Trembling of the extremities during movement.

**Interstitial pneumonitis**. Inflammation of the alveolar walls and the spaces between them.

**Iritis**. Inflammation of the colored part of the eye (iris).

**Ischemia**. Obstruction of blood flow (usually by arterial narrowing) that causes lack of oxygen and other bloodborne nutrients.

**Ischemic necrosis**. Death of cells as a result of decreased blood flow to affected tissues.

**Jaundice**. Yellowing of the skin and whites of the eyes due to an accumulation of bile pigments (e.g., bilirubin) in the circulating blood.

**Keratitis**. Inflammation of the cornea.

**Lacrimation**. Secretion of tears, especially in excess.

**Laryngeal edema**. Swelling of the voice box due to fluid accumulation.

**Laryngitis**. Inflammation of the mucous membrane of the larynx.

**Laryngospasm**. Spasmodic closure of the vocal apparatus.

**Lethargy**. A state of extreme tiredness or fatigue.

**Leukemia**. Progressive proliferation of abnormal leukocytes found in blood and blood-forming tissues and organs; due to cancer of the bone marrow cells that form leukocytes.

**Leukocyte**. White cell normally present in circulating blood.
Material safety data sheet (MSDS). Documents prepared by the chemical industry to transmit information about the physical properties and health effects of chemicals, and about emergency response plans.

**Methemoglobin**. A transformation product of hemoglobin in which normal $Fe^{+2}$ is oxidized to $Fe^{+3}$.

**Methemoglobin** contains oxygen that is firmly bound to the Fe+3 ion, which prevents the release of oxygen to the tissues.

**Methemoglobinemia**. Condition in which methemoglobin is present in the circulating blood.

**Methemoglobinuria**. Condition in which methemoglobin is present in the urine.

**Miosis**. Contraction of the pupil to a pinpoint.

**Miscible**. Able to mix (but not chemically combine) in any ratio without separating into two phases (e.g., water and alcohol).

**Mist**. Liquid droplets dispersed in air.

**Mitigation**. Actions taken to prevent or reduce the severity of harm.

**Monocytic leukemia**. A form of bone marrow cancer characterized by an increase in the number of large, mononuclear white blood cells in tissues, organs, and the circulating blood.

**Molecular weight**. The sum of the atomic weights (q.v.) of the atoms in a molecule; measured in daltons.

**Myalgia**. Severe muscle pain.

**Mydriasis**. Dilation of the pupil.

**Myelocytic leukemia**. A form of bone marrow cancer characterized by the presence of large numbers of granular white blood cells in tissues, organs, and the circulating blood.

**Myocardial ischemia**. Insufficient oxygen supply to meet the metabolic demands of heart muscles.

**Myocarditis**. Inflammation of the muscles of the heart.

**Myoclonus**. Involuntary spasm or twitching of a muscle or group of muscles.

**Myoglobin**. The oxygen-transporting, pigmented protein of muscle; resembles blood hemoglobin in function.

**Myoglobinuria**. Presence of myoglobin in urine.

**Nasopharynx**. Relating to the nasal cavity and that part of the throat that lies above the level of the soft palate.

**Necrosis**. Death of one or more cells or a portion of a tissue or organ.

**Nephrotoxic**. Capable of damaging the kidney.

**Neuropathy**. A disorder of the nervous system; in contemporary usage, a disease involving the cranial or spinal nerves.

**Noncardiogenic** pulmonary edema. An accumulation of an excessive amount of fluid in the lungs as a result of leakage from pulmonary capillaries; not due to heart failure.

**Nystagmus**. Involuntary rapid movements of the eyeballs, either rhythmical or jerky.

**Ocular**. Pertaining to the eye.

**Odor threshold**. The lowest concentration of a vapor or gas that can be detected by smell.

**Off-gassing**. Giving off a vapor or gas.

**Olfactory fatigue**. Temporary loss of the sense of smell due to repeated or continued stimulation.

**Oliguria**. Condition in which abnormally small amounts of urine are produced.

**Opisthotonos**. Tetanic spasm in which the spine and extremities are bent up and forward so that a reclining body rests on the head and the heels.

**Optic atrophy**. Shrinkage or wasting of the optic nerve that may lead to partial vision loss or blindness.

**Optic neuritis**. Inflammation of the optic nerve.

**Osteosclerosis**. Abnormal hardening or increase in density of the bone.

**Paresthesias**. An abnormal sensation such as burning, prickling, or tingling.

**Percutaneous absorption**. Passage of a substance through unbroken skin.

**Peripheral neuropathy**. A disorder of the peripheral nerves.

**Permeation**. The passage of chemicals, on a molecular level, through intact material such as protective

clothing.

**Permissible exposure limit (PEL)**. The maximum time-weighted average concentration mandated by the Occupational Safety and Health Administration (OSHA) to which workers may be repeatedly exposed for 8 hours per day, 40 hours per week without adverse health effects.

**Photophobia**. Abnormal sensitiveness to light, especially of the eyes.

**Physical state**. The state (solid, liquid, or gas) of a chemical under specific conditions of temperature and pressure.

**Pneumonitis**. Inflammation of the lungs.

**Poikilocytosis**. The presence of irregularly shaped red blood cells in the peripheral blood.

**Posthypoxic encephalopathy**. Condition in which the brain has been damaged as a result of insufficient oxygen.

**Proteinuria**. A condition in which an abnormal amount of protein is present in the urine. See also albuminuria.

**Pruritic**. Pertaining to itching.

**Psychosis**. A mental disorder characterized by derangement of personality and loss of touch with reality.

**Pulmonary edema**. Accumulation of extravascular fluid in the lungs that impairs gas exchange; usually due to either increased intravascular pressure or increased permeability of the pulmonary capillaries.

**Pupil**. The circular opening in the center of the iris through which light rays enter the eye.

**Reactivity**. The ability of a substance to chemically interact with other substances.

**Rescuer protection equipment**. Gear necessary to prevent injury to workers responding to chemical incidents.

**Respiratory depression**. Slowing or cessation of breathing due to suppression of the function of the respiratory center in the brain.

**Response organization**. An organization prepared to provide assistance in an emergency (e.g., fire department).

**Response personnel**. Staff attached to a response organization (e.g., HAZMAT team).

**Retrobulbar neuritis**. Inflammation of the portion of the optic nerve behind the eyeball.

**Rhinitis**. Inflammation of the mucous membranes of the nasal passages.

**Rhinorrhea**. A discharge from the nasal mucous membrane.

**Routes of exposure**. The manner in which a chemical contaminant enters the body (e.g., inhalation, ingestion).

**Sclera**. The tough, white supporting tunic of the eyeball.

**Secondary contamination**. Transfer of a harmful substance from one body (primary body) to another (secondary body), thus potentially permitting adverse effects to the secondary body.

**Self-contained breathing apparatus (SCBA)**. Protective equipment consisting of an enclosed facepiece and an independent, individual supply (tank) of air; used for breathing in atmospheres containing toxic substances or underwater.

**Sensory neuropathy**. Damage to the nerves that carry information about sensation (e.g., touch, pain, temperature) to the brain.

**Sequela (plural sequelae)**. A condition that follows as a consequence of injury or disease.

**Sloughing**. The process by which necrotic cells separate from the tissues to which they have been attached.

**Solubility**. The ability of one material to dissolve in or blend uniformly with another.

**Soluble**. Capable of being dissolved.

**Solution**. A homogeneous mixture of two or more substances, usually liquid.

**Solvent**. A substance that dissolves another substance.

**Specific gravity**. The ratio of the mass of a unit volume of a substance to the mass of the same volume of a standard substance (usually water) at a standard temperature.

**Status epilepticus**. Severe seizures in which recovery does not occur between major episodes.

**Stridor**. A harsh, high-pitched respiratory sound often heard in acute respiratory obstruction.

**Support Zone**. That area beyond the Decontamination Zone that surrounds a chemical hazard incident in which medical care can be freely administered to stabilize a victim.

**Surfactant**. An agent that reduces surface tension (e.g., wetting agents, detergents, dispersing agents).

**Tachycardia**. Rapid heartbeat (typically greater than 100 beats per minute).

**Tachypnea**. Rapid breathing.

**Teratogenic**. Having the ability to cause congenital anomalies.

**Tetany**. A condition marked by involuntary muscle contractions or spasms.

**Thrombocytopenia**. A condition in which there is an abnormally small number of platelets in the blood.

**Thrombosis**. Blood vessel clotting.

**Time-weighted average (TWA) air concentration**. That concentration of a substance in air that is measured by collecting it on a substrate at a known rate for a given period of time.

**Tinnitus**. Ringing in the ears.

**Toxic potential**. The inherent ability of a substance to cause harm.

**Toxic**. Having the ability to harm the body, especially by chemical means.

**Tracheitis**. Inflammation of the membrane lining the trachea.

**Trismus**. Lockjaw.

**Tubular necrosis**. Death of the cells lining the kidney tubules.

**Uremia**. Condition in which an abnormally high level of urea or other nitrogenous waste is found in the blood; due to kidney dysfunction.

**Urticaria**. Hives.

**Vapor density**. The weight of a given volume of vapor or gas compared to the weight of an equal volume of dry air, both measured at the same temperature and pressure.

**Vapor pressure**. A measure of the tendency of a liquid to become a gas at a given temperature.

**Vapor**. The gaseous form of a substance that is normally a solid or liquid at room temperature and pressure.

**Vascular**. Pertaining to blood vessels.

**Vasodilation**. Increased diameter of the blood vessels.

**Ventricular fibrillation**. Rapid, tremulous movement of the ventricle that replaces normal contractions of the heart muscle; results in little or no blood being pumped from the heart

**Vertigo**. Sensation of spinning or revolving.

**Vesicant**. An agent that produces blisters.

**Vesiculation**. The presence or formation of blisters.

**Water-reactive material**. A substance that readily reacts with water or decomposes in the presence of water, typically with substantial energy release.

**Wheezing**. Breathing noisily and with difficulty; usually a sign of spasm or narrowing of the airways.