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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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.

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.

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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

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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

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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

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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 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 website: 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) (Oregon State University)	1-800-858-7378 website: 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 7600 Sand Point Way, N.E. Seattle, Washington 98115 (206) 526-6317 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. c/o Oxford Molecular Group 11350 McCormick Road Executive Plaza, Suite 1100 Hunt Valley, Maryland 21031 (800) 247-8737 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. Suite 300 6200 S. Syracuse Way Englewood, Colorado 80111-4740 (800) 525-9083 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 Information Systems Manager U.S. Department of Transportation D.H.M. 63 - Room 8104 400 7th Street SW Washington, D.C. 20590-0001 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 National Library of Medicine Specialized Information Systems 8600 Rockville Pike Bethesda, Maryland 20894 (301) 496-6531 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. Suite 300 6200 S. Syracuse Way Englewood, Colorado 80111 (800) 525-9083 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. Suite 300 6200 S. Syracuse Way Englewood, Colorado 80111 (800) 525-9083 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. 11350 McCormick Rd. Executive Plaza 3, Suite 1100 Hunt Valley, Maryland 21031 (800) 247-8737 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. Suite 300 6200 S. Syracuse Way Englewood, Colorado 80111 (800) 525-9083 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) National Library of Medicine Specialized Information Services 8600 Rockville Pike Bethesda, Maryland 20894 (301) 496-6531 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 Chest tightness leukemia 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.

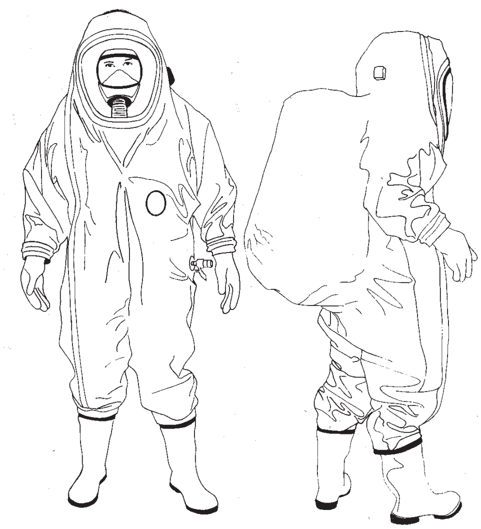
Exhibit II-8 illustrates these four levels of protection. For more information on this subject, Appendix C outlines the protective equipment recommended for each level of protection.

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.

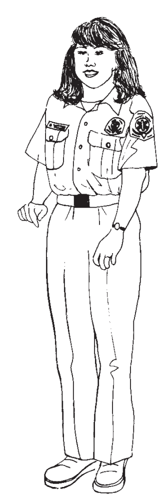
Exhibit II-8
Levels of Protection



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).

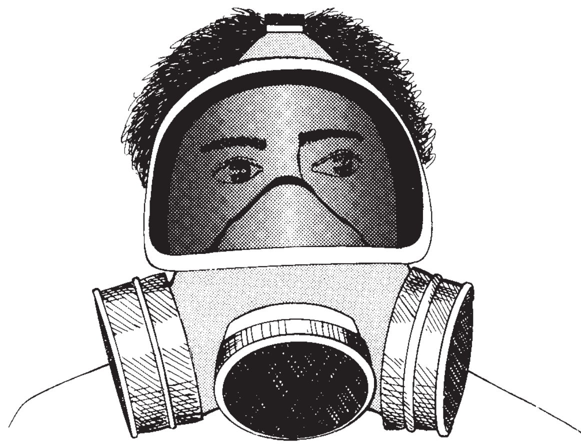
Air-Purifying Respirators (APRs)

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

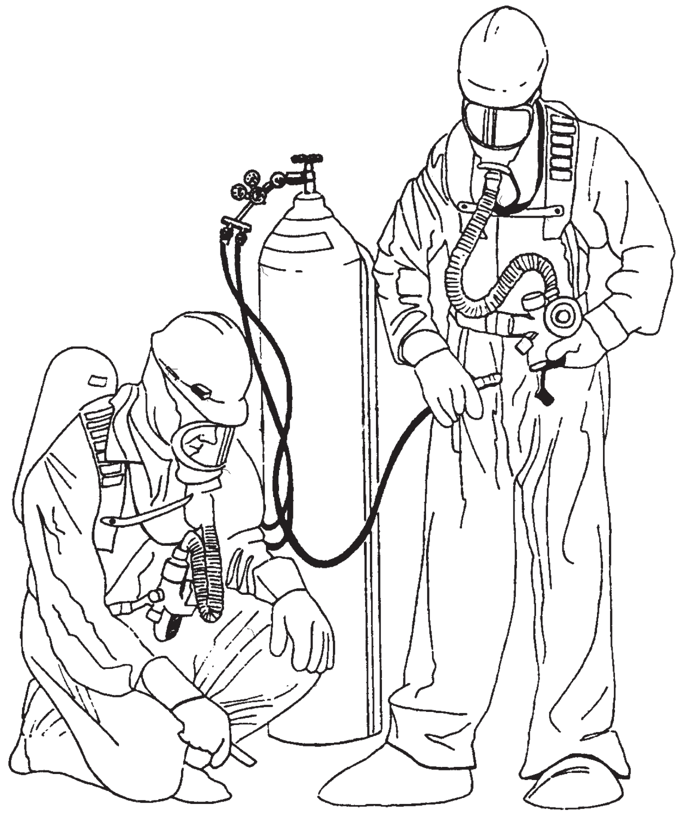
Atmosphere-supplying respirators consist of two basic types: the self-contained breathing apparatus (SCBA), which contains its own air supply, and the supplied-air respirator (SAR), which depends on an air supply provided through a line linked to a distant air source. Exhibit II-10 illustrates an example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

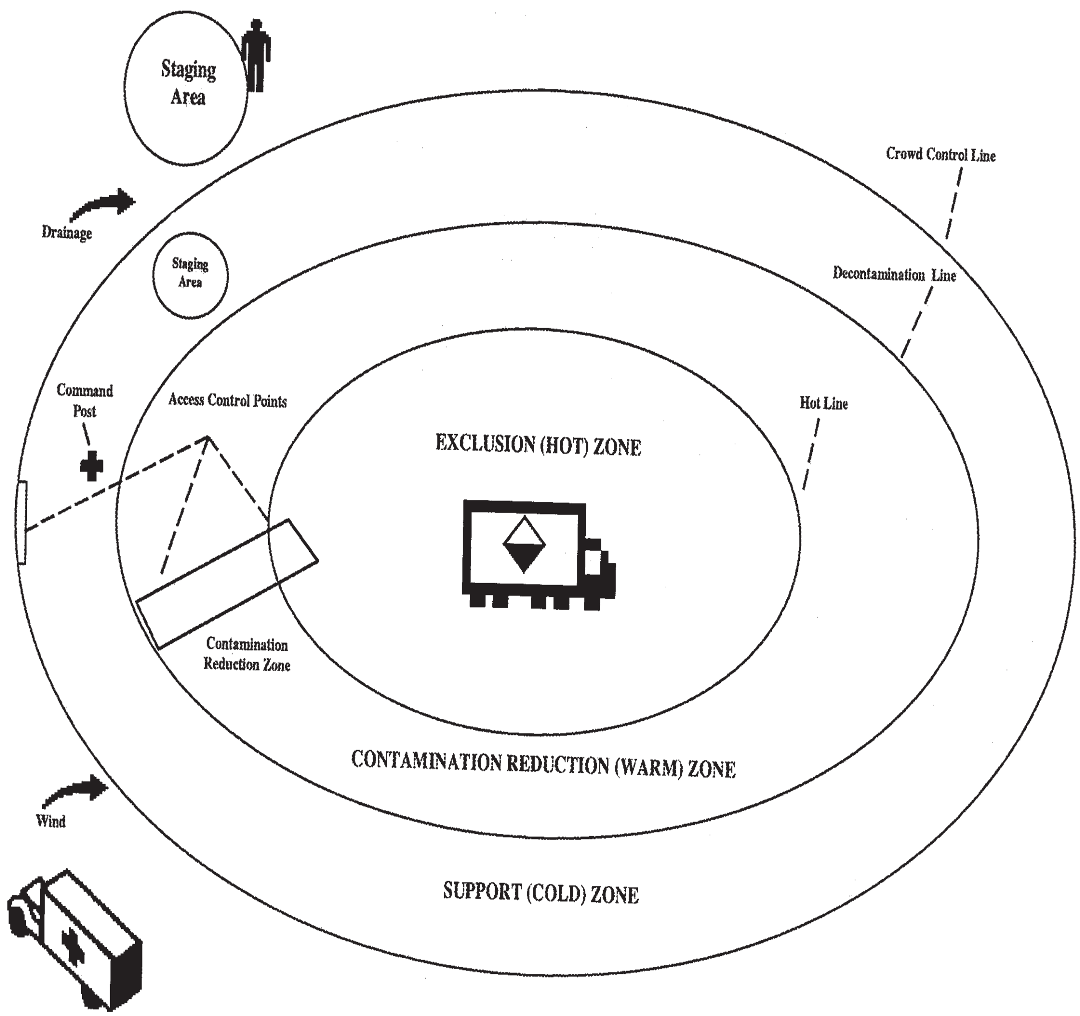
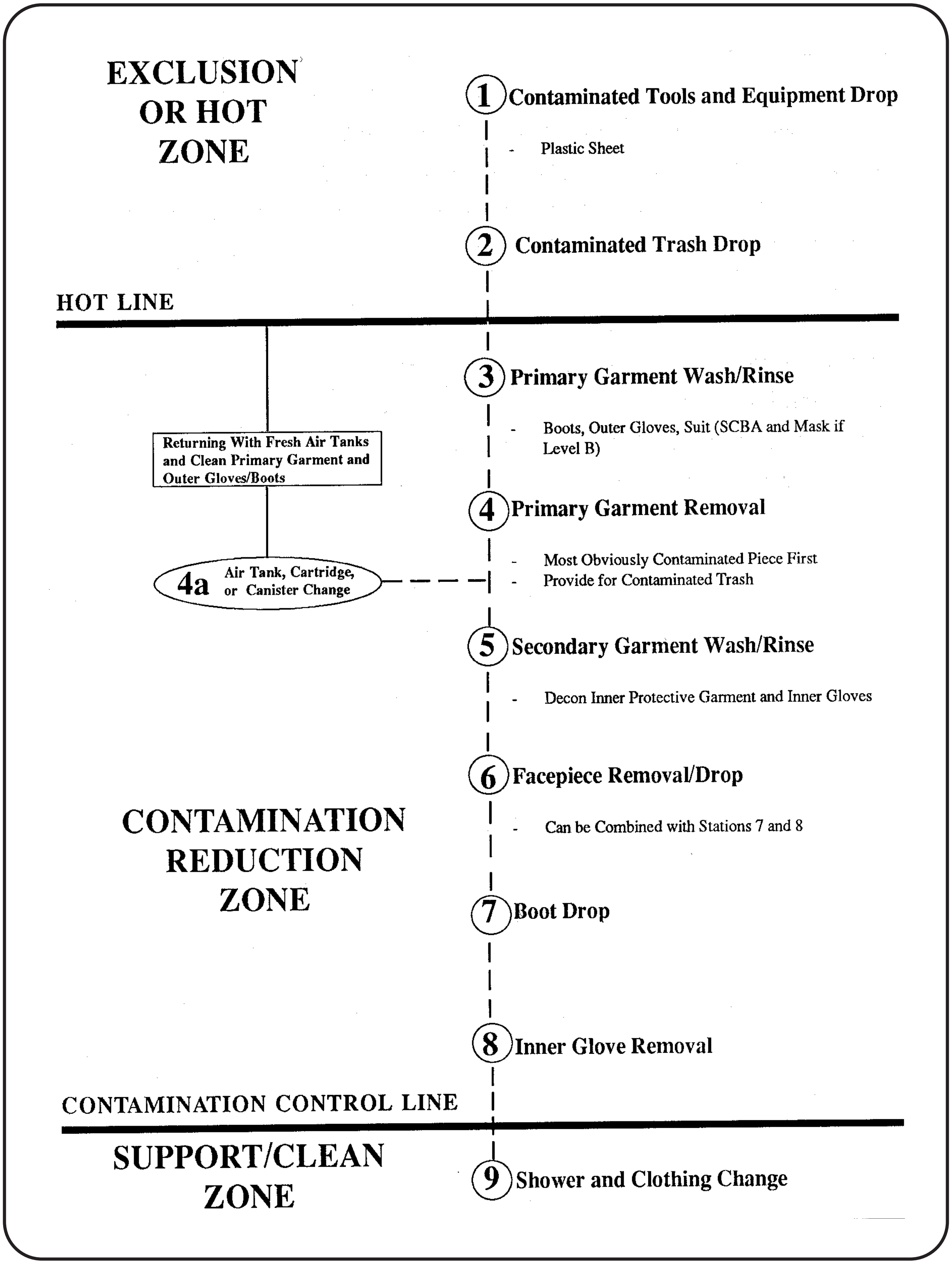


Exhibit II-12
Nine-Step Personnel Decontamination Plan



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Section III. Patient Management

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

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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.

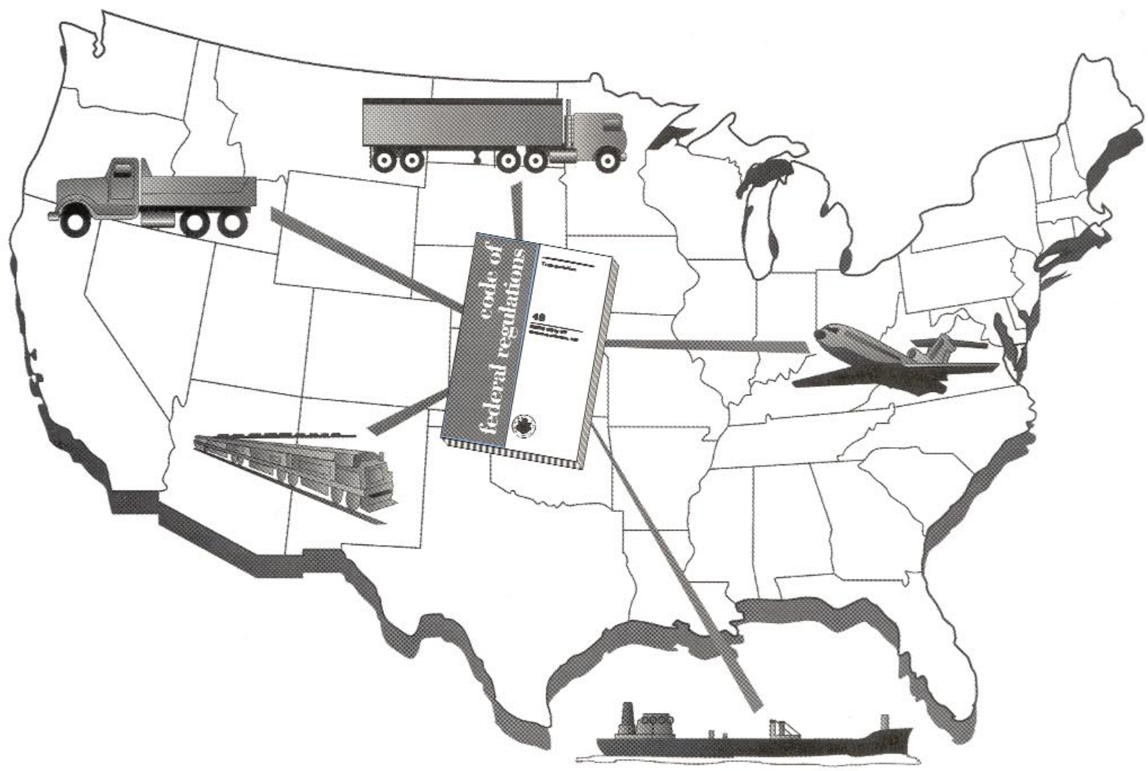
Special Information (White)

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:

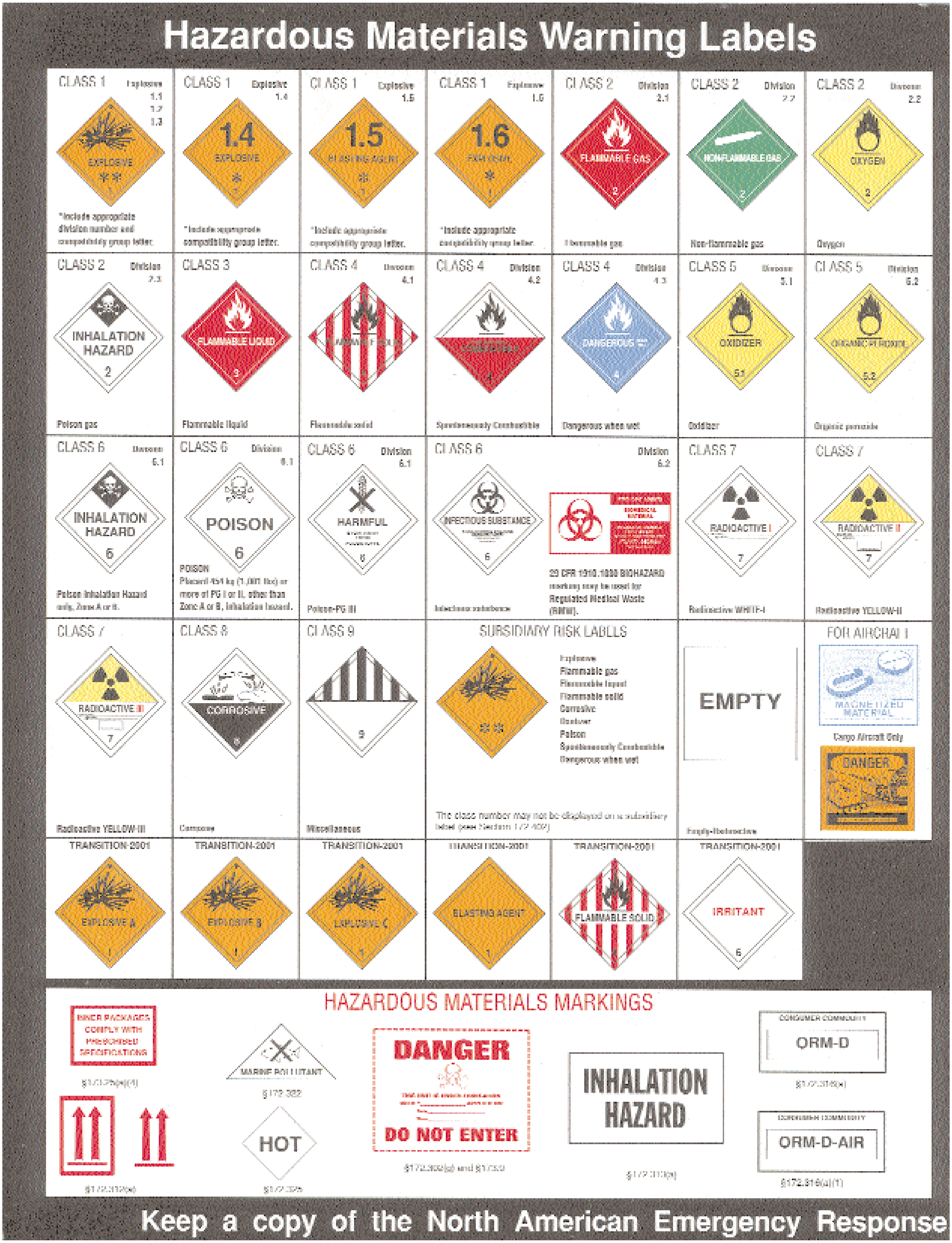
Marking - Subpart D

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
CLASS 1 Explosive 1.1 1.2 1.3
EXPLOSIVE
*Include appropriate division number and compatibility group letter.
CLASS 1 Explosive 1.4
1.4 EXPLOSIVE
*Include appropriate compatibility group letter.
CLASS 1 Explosive 1.5
1.5 BLASTING AGENT
*Include appropriate compatibility group letter.
CLASS 1 Explosive 1.6
1.6 EXPLOSIVE
*Include appropriate compatibility group letter.
CLASS 2 Division 2.1
FLAMMABLE GAS
Flammable gas
CLASS 2 Division 2.2
NON-FLAMMABLE GAS
Non-flammable gas
CLASS 2 Division 2.2
OXYGEN
Oxygen
CLASS 2 Division 2.3
INHALATION HAZARD
Poison gas
CLASS 3
FLAMMABLE LIQUID
Flammable liquid
CLASS 4 Division 4.1
Flammable solid
CLASS 4 Division 4.2
Spontaneously Combustible
CLASS 4 Division 4.3
DANGEROUS WHEN WET
Dangerous when wet
CLASS 5 Division 5.1
OXIDIZER
Oxidizer
CLASS 5 Division 5.2
ORGANIC PEROXIDE
Organic peroxide
CLASS 6 Division 6.1
INHALATION HAZARD
Poison Inhalation Hazard only, Zone A or B.
CLASS 6 Division 6.1
POISON
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
HARMFUL
Poison-PG III
CLASS 6 Division 6.2
INFECTIOUS SUBSTANCE
Infectious substance
29 CFR 1910.1030 BIOHAZARD marking may be used for Regulated Medical Waste (RMW).
CLASS 7
RADIOACTIVE I
Radioactive WHITE-I
CLASS 7
RADIOACTIVE II
Radioactive YELLOW-II
CLASS 7
RADIOACTIVE III
Radioactive YELLOW-III
CLASS 8
CORROSIVE
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
MAGNETIZED MATERIAL
Cargo Aircraft Only
DANGER
TRANSITION-2001
EXPLOSIVE A
TRANSITION-2001
EXPLOSIVE B
TRANSITION-2001
EXPLOSIVE C
TRANSITION-2001
BLASTING AGENT
TRANSITION-2001
FLAMMABLE SOLID
TRANSITION-2001
IRRITANT
HAZARDOUS MATERIALS MARKINGS
INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS
MARINE POLLUTANT
§172.322
DANGER
DO NOT ENTER
§172.302(g) and §173.9
INHALATION HAZARD
§172.313(a)
CONSUMER COMMODITY
ORM-D
CONSUMER COMMODITY
ORM-D-AIR
§172.316(a)(1)
HOT
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.

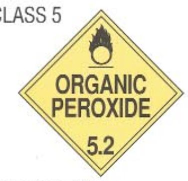
CLASS 4

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.

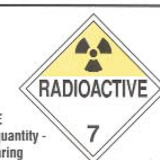
CLASS 6

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 contaiminated objects transported in accordance with §173.427 (b)(3) or (c).

CLASS 8

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

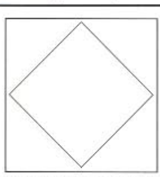
CLASS 9

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.

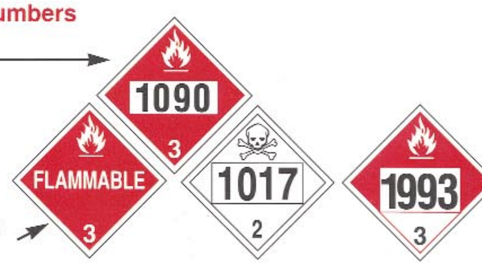


White square background required for placard for highway route controlled quantity radioactive material and for rail shipment of certain explosives and poisons, and for flammable gas in a DOT 113 tank car (see §§172.507 and 172.510).

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

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) (also called air line respirator)	Enables longer work periods than an SCBA Less bulky and heavy than an SCBA; SAR equipment weigh less than 5 pounds (or around 15 pounds, if escape SCBA protection is included) Protects against most airborne contaminants	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 Impairs mobility 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

Levels of Protection

Appendix C
Levels of Protection[1]

Level of Protection	Equipment	Protection Provided	Should be used when:	Limiting Criteria
A	**Recommended:** Pressure-demand, full facepiece SCBA or pressure-demand, supplied-air respirator with escape SCBA Fully-encapsulated, chemical-resistant suit Inner chemical-resistant gloves Chemical-resistant safety boots/shoes 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: -measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or -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: Cooling unit Coveralls Long cotton underwear Hard hat 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 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:** Pressure-demand, full-facepiece SCBA or pressure-demand, supplied-air respirator with escape SCBA Chemical-resistant clothing (overalls and long sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit) Inner and outer chemical-resistant gloves Chemical-resistant safety boots/shoes Hard hat Two-way radio communications **Optional:** Coveralls Disposable boot covers Face shield Long cotton underwear	The same level of respiratory protection, but less skin protection than Level A 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: -atmosphere with IDLH concentrations of specific substances that do not represent a severe skin hazard; or -atmosphere containing less than 19.5 percent oxygen 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 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:** Full-facepiece, air-purifying, canister-equipped respirator Chemical-resistant clothing (overalls and long sleeved jacket: hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit) Hard hat **Optional:** Gloves Escape mask Face shield	No respiratory protection; minimal skin protection	The atmosphere contains no known hazard 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 The atmosphere must contain at least 19.5 percent oxygen
D	**Recommended:** Coveralls Safety boots/shoes Safety glasses or chemical splash goggles Hard hat **Optional:** Gloves Escape mask Face Shield	No respiratory protection; minimal skin protection	The atmosphere contains no known hazard 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 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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