CHAPTER 2

ELEMENTS OF HOLISTIC PLANNING AND MANAGEMENT

INTRODUCTION

Whether at the level of the community or individual corporation, emergency response planning and management require the coordination of a wide range of information, services, and materials. Clearly, much of the information required and the services and materials needed in the response phase are highly specific with regard to location and attendant circumstances. However, there are certain aspects of emergency response planning and management that are categorically appropriate to all emergency response efforts and that may therefore be called universal elements of holistic planning and management, including:

- Scope of Emergency Planning: It is essential that planning proceed from the premise that the objective of planning is inclusive of (a) the prevention of an emergency, (b) preparation for the occurrence of an emergency, and (c) actual response to an emergency.
- Assessment of Hazard and Risk: Hazard assessment is the identification of potential harm and injury, while risk assessment is the probability of harm and injury to specific persons and groups. Hazard assessment is a necessary first step toward realistic risk assessment, but the estimation of actual risks also depends upon the analysis of potential exposures of defined persons and groups to individual hazards.
- On- and Off-Site Management: While the site of an actual emergency is typically taken to be the location of actual response efforts, those efforts trigger many activities that affect off-site locations. In some instances,

the off-site sequellae of a distantly located emergency can be more disastrous than on-site consequences. This is particularly the case when an act of terrorism is involved and the strategy is to implement a series of interrelated but individually staged incidents.

- Authority and Responsibility: Whether in prevention, preparation, or response phases, emergency response planning must be built on absolutely clear lines of authority and responsibility. During the response phase, this is usually referred to as "Incident Command."
- Communications and Information Handling: Communications and information handling are key activities throughout prevention, preparation, and response phases of emergency planning and management.
- Provisions and Support: Provisions are the equipment, supplies, and materials that are immediately on-hand to prevent or contain an emergency incident. Support from off-site sources, including governmental agencies and private contractors, must also be provided for in any comprehensive emergency management program.
- Medical Treatment and Surveillance: Medical treatment and surveillance are inclusive of all first-aid and subsequent medical treatment of acutely affected victims as well as long-term follow-up examinations to monitor for emergent chronic health effects.
- Remediation and Review: Both during and after an emergency incident, appropriate remedial actions must be taken to protect against further harm or injury due to secondary effects of the emergency (e.g., structural damage, runoff of hazardous materials, hazardous debris); remedial actions also include those taken to recharge or replace supplies and materials depleted in the initial response effort. All remediation efforts should be given first priority in the comprehensive review and evaluation of the emergency incident.

Each of these elements requires comprehensive examination of diverse types of information, including information and data related to procedures, operations, equipment, and materials. Within individual corporations, they may well require reconsideration of normal chains of command and procedures which, after all, typically reflect the needs of productivity and quality control as opposed to the real needs of effective emergency management. At the level of the community, the complexity of these issues and concerns is typically constrained by legal jurisdictional authority among governmental authorities and agencies.

SCOPE OF EMERGENCY PLANNING

The acronym HSE (health, safety, environment) is frequently used in the international literature to denote the paradigm of Integrated Environmental Planning and Management. This paradigm, essentially formulated by the United Nations Conference on Environment and Development (UNCED), commonly known as the Earth Summit (Rio, 1992), is based on a broad consensus that the management of human health and safety and the management of environmental quality can be carried out more efficiently when both efforts are integrated. This consensus is expressed in the 1992 U.N. Earth Summit Agenda and has important social ramifications for both public and private sector decision making:

> The primary need is to integrate environmental and developmental decision-making processes. To do this, governments should conduct a national review and, where appropriate, improve the processes of decision-making so as to achieve the progressive integration of economic, social, and environmental issues in the pursuit of development that is economically efficient, socially equitable and responsible, and environmentally sound. (1992 Earth Summit Agenda 21, p.66)

While the terms *occupational safety and health* (OSH), *environmental safety and health* (ESH), and *environmental quality* (EQ) are still commonly used to focus, respectively, on workplace, nonworkplace, and environmental contributions to human health and safety, it is widely understood that such distinctions may often obscure rather than clarify dynamic linkages (Fig. 2.1) between environmental processes and attributes, human

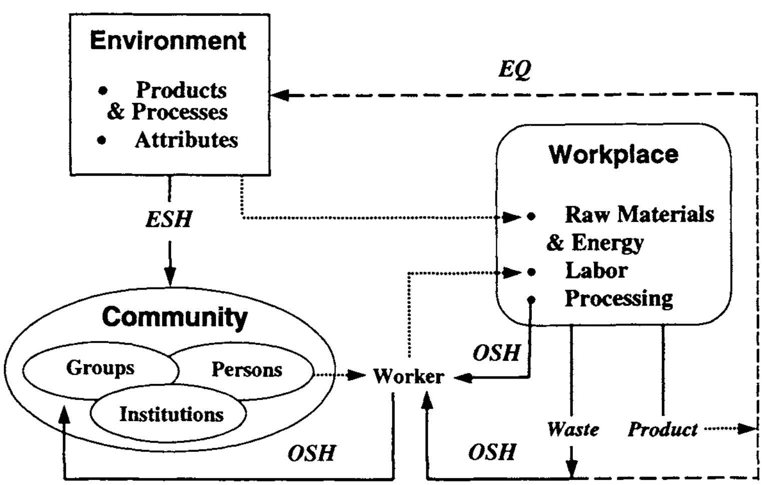

FIGURE 2.1 Holistic view of dynamic linkages between the environment, community, and workplace (EQ, environmental quality; ESH, environmental safety and health; OSH, occupational safety and health). Heavy solid lines represent issues historically addressed by U.S. regulations; heavy dotted lines represent issues likely to be given increased regulatory attention; light dotted lines indicate basic operational or functional relationships.

activities (e.g., work), and human health and safety. It is precisely these dynamic linkages that must inform any comprehensive approach to emergency planning and response.

For example, if the focus of planning efforts becomes simply the knockdown of a structural fire in a manufacturing plant, it is likely that relatively little attention will be given to the management of the water runoff that results from firefighting activities. However, such runoff may contain hazardous chemicals that, if allowed to infiltrate into ground- or surface-water supplies, may result in a subsequent emergency involving contaminated drinking water.

Another example might be an emergency incident involving the release into the community of toxic vapors or particulates as a result of a highway accident involving a chemical tank truck. While the obvious emergency incident is the accident scene, less obvious is the possibility that some of those vapors or particulates may become entrained into the ventilation systems of even distantly located downstream plants and other facilities—which may result in subsequent chronic effects on workers.

By focusing our attention upon interconnected environmental, community, and workplace dynamics, the HSE paradigm requires emergency planning and response to give specific and detailed attention to the fact that any emergency *incident* is also a *systemic* threat, with possible consequences that can extend well beyond the particular spatial or temporal coordinates of the incident itself.

ASSESSMENT OF HAZARD AND RISK

The term *hazard* (Fig. 2.2) is sometimes used to define a source of potential harm or injury and, sometimes, the potential harm or injury itself. Thus, a silo containing plastic chips or grain or any other raw materials may be said to be a hazard because, having entered the silo, a worker might become engulfed and subsequently asphyxiated; the hazard also may be defined as the engulfment or the asphyxiation. This double meaning of the word hazard (i.e., the silo itself or the dangers that exist within a silo) often results in a confusion of cause and effect. However used, the word hazard always denotes a *possibility or potential.* This is what differentiates a hazard from a risk. Whereas a hazard is a possible (or potential) harm or injury (or an immediate precursor to harm or injury), risk is the *probability* that a person or group will actually experience a specific hazard. As the probability that individual persons or groups will experience the harm or injury of a specific hazard, risk depends upon *exposure* of those persons or groups to the actual hazard. Emergency response planning, whether at the corporate or the municipal level, begins with a comprehensive inventory of hazards

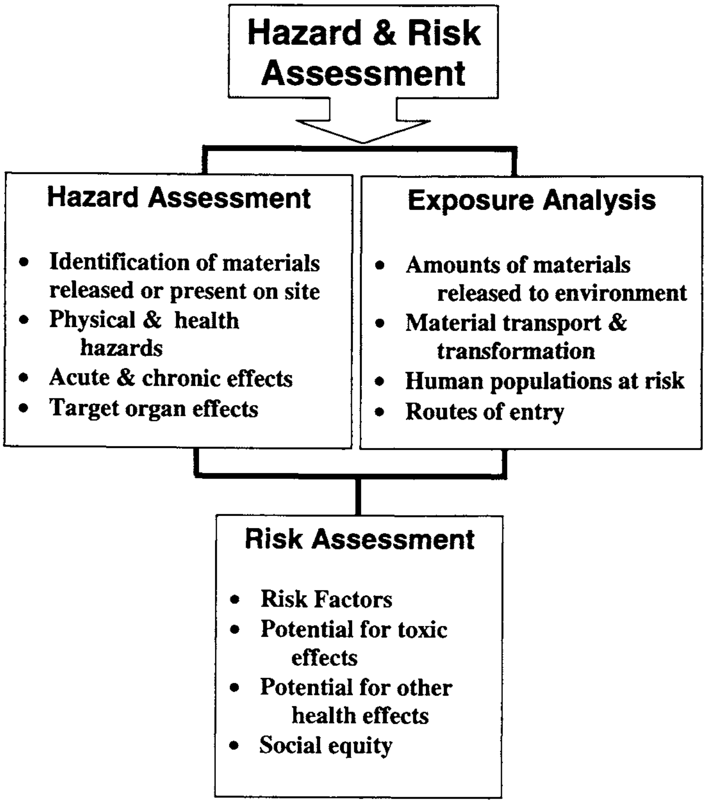

FIGURE 2.2 Elements of hazard and risk assessment.

and proceeds in a stepwise fashion to the analysis of exposure and, finally, the estimation of risk.

As shown in Fig. 2.3, the assessment of hazards, exposure, and risk may be considered the first of three phases of decision making required for devising effective emergency response policies and procedures that form the basis of the *emergency response* or *action plan*:

- Risk Assessment Phase: identification of the potential sources or cause of emergencies and the types and degrees of risk to be experienced by the work force, the public at large, and emergency response personnel
- Safety Judgment Phase: establishment of levels of protection to be provided to persons at risk during an emergency
- Make-Safe Strategy Phase: formulation of specific procedures of achieving decided levels of protection

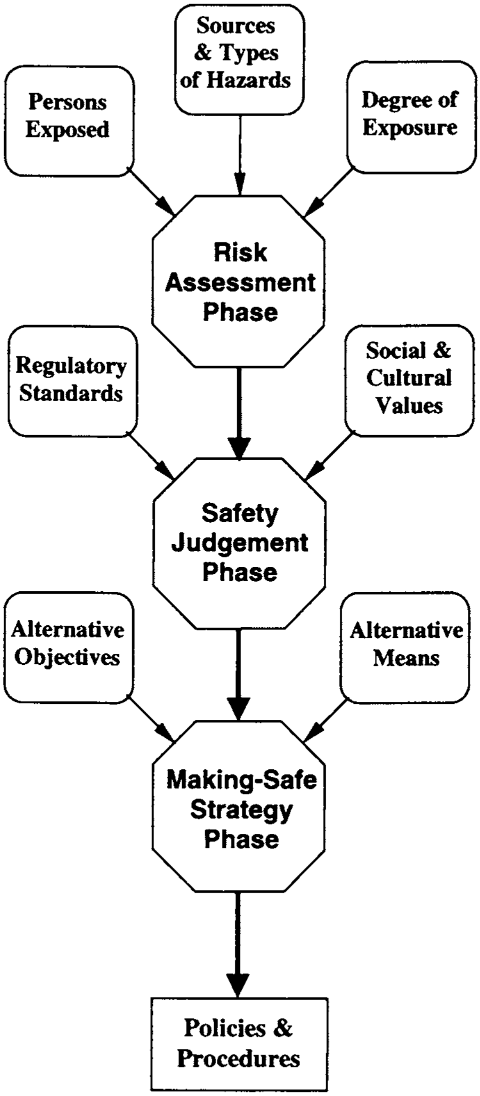

FIGURE 2.3 Phases of decision making in emergency response planning.

Risk Assessment Phase

The risk assessment phase (often called simply "hazard assessment") is highly influenced by the concerns and considerations broadly attendant to the Bhopal (India) tragedy in which 4000 people died and 30,000–40,000 persons were seriously injured due to a leak of toxic gas at a Union Carbide pesticide plant—an event that, in the United States, became a prime motivation of the development of the Chemical Process Safety Regulations (29 CFR 1910.119). Even where these regulations do not specifically apply, they provide an excellent overview of the broad scope of modern emergency planning and are thereby highly instructive for any emergency response manager.

Various analytical techniques are germane to this phase—each of them providing different means for identifying potential sources of workplace emergencies and persons potentially at risk. Standard techniques (Fig. 2.4) include (a) preliminary hazard analysis, (b) what-if analysis, (c) hazard and operability analysis, (d) failure modes and effects analysis, (e) fault and even tree analysis, and (f) human reliability analysis.

Preliminary Hazard Analysis focuses on the hazardous materials and major processing areas of a plant in order to identify hazards and potential accident situations. It requires consideration of plant equipment, the interface among plant components, the operational environment, specific plant operations, and the physical layout of the plant. The objective of this technique is to assign a criticality ranking to each hazardous situation that may be envisioned, even in the absence of specific information about plant design features or operational procedures. It is particularly useful for identifying broadly defined causal chains (e.g., fire in materials processing can lead to explosion and release of toxic vapors; release of toxic vapors will be to the ambient atmosphere, and may threaten homes abutting company property) that can then be subjected to more detailed analysis.

What-if Analysis requires experienced personnel to formulate a series of questions that must be evaluated with respect to potential hazards identified in the preliminary hazard analysis. Typical questions might be of the type, "What if pump 23-b shuts off?" and "What if the operator forgets to empty the overflow tank at the end of the week?"

The basic strength of this approach is to define more precisely specific causal chains that can lead to an emergency.

Hazard and Operability Analysis depends upon detailed information on the design and operation of the facility. In using this technique, the assessment team uses a standard set of *guide words* that, when combined with specific *process parameters*, lead to *resultant deviations* that may result in an emergency heath and safety situation. For example, the guide word "less" might be combined with the process parameter "pressure" to produce the resultant deviation "low pressure." The assessment team may then focus on the possible causes of low pressure (e.g., in a reactor) and the possible consequence of that low pressure (e.g., change in the rate of chemical reaction in the reactor).

Failure Modes and Effects Analysis is closely related to "what if analysis." This technique focuses on the various failure modes of specific

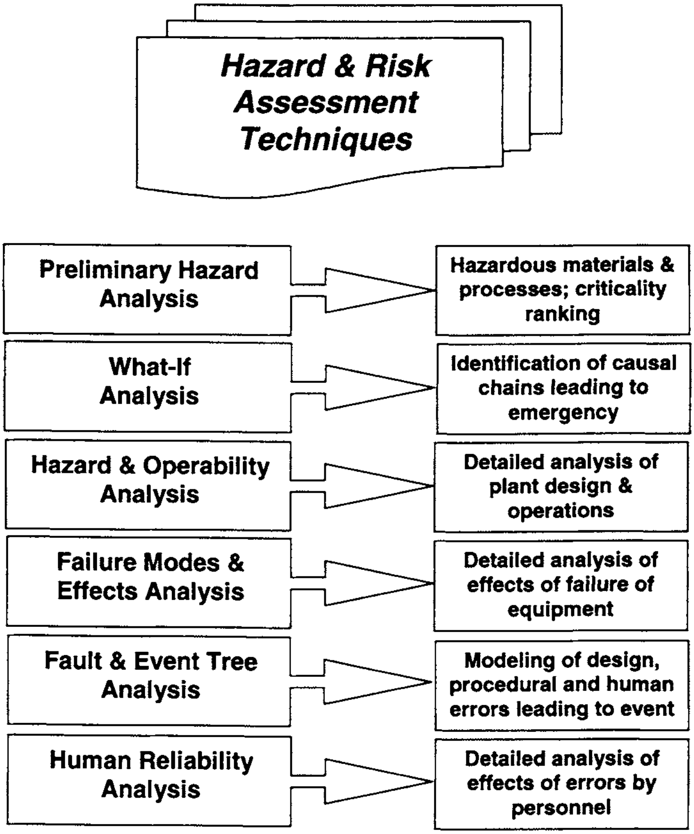

FIGURE 2.4 Examples of formalized hazard and risk assessment techniques.

equipment and the effects of such failures on plant operations and human health and safety. Examples of questions that reflect this type of analysis when applied, say, to a control valve in a reactor vessel might include: What are the possible consequences of the control valve failing in the open position? In the closed position? What are the possible consequences if the control valve leaks while in the open or closed position?

Fault Tree Analysis and *Event Tree Analysis* involve graphically modeling accidents and failures in equipment and personnel. In fault tree analysis, a specific accident or plant failure (e.g., release of a toxic gas) is defined and all design, procedural, and human errors leading to that event (called the "top event") are graphically modeled in a *fault tree*. The fault tree allows the analysis to define and rank particular groupings of external factors, equipment failures, and human errors (which are called "minimal cut sets") that are sufficient to lead to the top event. While fault tree analysis focuses on failures in equipment or personnel that lead to the top event, event tree analysis focuses on how successes or failures of specific in-place safety equipment, devices, and procedures may contribute to a developing emergency. This type of analysis is typically used to analyze very complex processes that incorporate several layers of safety systems or emergency procedures.

Human Reliability Analysis is generally conducted in parallel with other techniques, which tend to be equipment-oriented. This type of assessment focuses on factors that influence the actual job performance of personnel. In such an assessment, detailed descriptions of task requirements, the skills, knowledge, and capabilities necessary for meeting each requirement, and error-prone situations that may develop during task performance are combined to isolate specific factors that, if ignored, might result in an emergency. It is important that considered factors not be limited to those that are directly related to workplace conditions (e.g., ambient noise levels, which might affect a worker's concentration; work schedules, which can result in inattention due to fatigue), but are inclusive of the universe of factors that may influence workplace performance (e.g., personal financial difficulties, marital problems, substance abuse).

Regardless of the individual technique (or combination thereof) employed, the risk assessment process must consider potential sources of emergency that derive from other than plant operations, including storms and floods, area-wide fires and chemical releases, and terrorist acts. With regard to the latter, it is advisable that particular attention be given to the fact that a perceived emergency may well be a "blind" to another.

For example, a telephoned bomb threat is likely to result in a plant evacuation within a matter of minutes, followed closely by the arrival of fire, police, and/or other specialized investigatory and emergency response units. However, it may be the evacuating personnel or the emergency response personnel, not the physical facility, who are the real targets of the threat. Given this possibility, the prudent planner would ensure the implementation of appropriate procedures for detecting explosive or toxic charges that may be planted in evacuation assembly areas or precisely where emergency vehicles are likely to enter the premises.

Safety Judgment Phase

Having identified potential sources of emergencies as well as contributing factors and populations at risk, emergency planners must establish criteria regarding appropriate levels of protection for each at-risk population. This is a very difficult task precisely because it requires that judgments be made directly affecting the safety of human beings. The simple fact is that there is no such thing as "100% guaranteed protection" for all. The mere act of evacuating a group of people from a building puts some of those people at great risk of suffering a heart attack or a fall-related injury; panic can kill as effectively as fire. Of course, individual physical and psychological conditions that ensure some differential distribution of risks regardless of any effort to the contrary are not excuses for inaction. In fact, it is precisely the recognition of a differential distribution of risks that becomes the basis of an effective emergency response plan.

In the United States, regulatory guidance (OSHA and EPA) regarding the level of protection for personnel having specific responsibility in an emergency involving hazardous chemicals is based on the following typology of emergency responders, which includes members of so-called HAZMAT (for "hazardous materials") teams. The designation HAZMAT always denotes personnel who are expected to perform work in close proximity to a hazardous substance while handling or controlling actual or potential leaks or spills, and should not be confused with other emergency personnel, such as members of a fire brigade.

- Level 1: responders who are not likely to witness or discover a hazardous substance release and to initiate an emergency response sequence by notifying the proper authorities
- Level 2: police, firefighters, and rescue personnel who are part of the initial response to a release or potential release of hazardous substances
- Level 3: HAZMAT technicians, who are the first level specifically charged with trying to contain a release of hazardous substances
- Level 4: HAZMAT specialists, who respond with and provide support to HAZMAT technicians and have more specific knowledge of hazardous substances
- Level 5: On-scene *incident commanders* or *senior officials in charge,* who assume control of the emergency response incident scene and coordinate all activities and communications

The various levels of responders indicated above can be cross-referenced with various levels of protective ensembles (Table 2.1) to meet regulatory requirements regarding personal protective clothing and equipment, such as the requirements of 29 CFR 1910.120. While the above typology of responders gives heavy emphasis to protection from hazardous chemicals, other types of emergency situations and job tasks require other regulatory inputs to the planning process, such as 29 CFR 1910.156 standards that specifically apply to members of a fire brigade.

In the process of coordinating with community-based emergency responders, including local fire departments, particular attention should be given to the adequacy of protective clothing and equipment available to external responders with respect to the specific hazards associated with com-

TABLE 2.1 Protective Clothing That May Be Included in Ensembles for Hazardous Waste Operations (Adapted from NIOSH, USCG, and EPA, 1985: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities)

Level of Protection and Equipment	Overview of Protection	Conditions for Use and Limitations
A **Recommended:** • Pressure-demand, full-facepiece SCBA or pressure-demand supplied air respirator with escape SCBA • Fully encapsulating, chemical resistant suit • Inner chemical-resistant gloves • Chemical resistant safety boots/shoes • Two-way radio **Optional:** • Cooling unit • Coveralls • Long cotton underwear • Hard hat • Disposable gloves and boot covers	The highest available level of respiratory, skin, and eye protection	• The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either: 1. measured (or potential for) high concentration of atmospheric vapors, gases, or particulates, or 2. 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. • 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. • Fully encapsulating suit materials must be compatible with the substances involved.
B **Recommended:** • Pressure-demand, full facepiece SCBA or pressure-demand supplied air respirator with escape SCBA • Chemical-resistant clothing • Inner and outer chemical-resistant gloves • Chemical resistant safety boots/shoes • Hard Hat • Two-way Radio **Optional:** • Coveralls • Disposable boot covers • Face shield • Long cotton underwear	The same level of respiratory protection but less skin protection than Level A. This the minimum level recommended for initial site entries until the hazards have been further identified.	• The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres -- with IDLH concentrations of specific substances that do not represent a severe skin hazard, or -- that do not meet the criteria for use of air-purifying respirators. • Atmosphere contains less than 19.5 % 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 highly unlikely that the work will generate either high concentrations of vapors, gases, or particulates or splashes of material will affect exposed skin.

continues

TABLE 2.1—*continued*

Level of Protection and Equipment	Overview of Protection	Conditions for Use and Limitations
C **Recommended:** • Full-facepiece, air purifying, canister equipped respirator • Chemical resistant clothing • Inner and outer chemical resistant gloves • Chemical resistant safety boots/shoes • Hard hat • Two-way radio **Optional:** • Coveralls • Disposable boot covers • Face shield • Escape mask • Long cotton underwear	The same level of skin protection as Level B, but a lower level of respiratory protection	• Atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin. • The types of air contaminants have been identified, concentrations measured, and a canister is available that can remove the contaminant. • All criteria for the use of air-purifying respirators are met. • Atmospheric concentration of chemicals must not exceed IDLH levels. • The atmosphere must contain at least 19.5 % 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 % oxygen.

pany operations. This is often a critical concern because the local fire firefighter or other local responder, who is usually the first responder to an emergency, typically does not have direct access to the kind of personnel protection devices that are standard equipment for a formal HAZMAT, which can often arrive on-site only well after an emergency has progressed.

In many cases, for example, local firefighters will not be equipped with chemically impervious protective clothing that would be required to retrieve personnel trapped within a facility where highly toxic chemicals are used or stored. In some situations, corporations have purchased such clothing and maintain it for use by local firefighters. Sometimes a company may also supply the local fire department with additional materials and specialized equipment, including antidotes to toxic chemicals used on-site, specialized monitoring devices, and materials that firefighters can use to disinfect clothing and equipment contaminated by especially dangerous chemicals.

Making-Safe Strategy Phase

In this phase, the objective is to assess and select from alternative means for achieving the standards and objectives previously identified and, finally, to develop specific policies and procedures that govern all aspects of emergency response. As shown in Fig. 2.5, policies and procedures should address three basic types of emergency response activities: (a) preparation activities, which are undertaken immediately upon discovery of a potential or actual emergency and prior to the initiation of any response; (b) response activities, which include all efforts to control the emergency and provide assistance to affected persons; and (c) follow-up activities, which focus on postemergency actions to bring the facility or emergency site back to a state of emergency readiness, including revisions to emergency plans necessitated by the experience of the now-past emergency. It must here be emphasized that the usual tendency is for companies to concentrate on the response to an emergency at the expense of attention given to both preparatory and follow-up actions—which is an extremely dangerous approach to emergency planning. Effective emergency planning always requires equally serious attention to all three types of actions. A checklist of basic issues that must be addressed in any comprehensive emergency response plan is included in Table 2.2.

ON- AND OFF-SITE MANAGEMENT

Proactive and reactive emergency response activities are essentially exercises in *risk management*. The basic generic steps of risk management, shown in Fig. 2.6, including (1) identification of risk exposure, (2) evaluation of risk potential, (3) ranking and prioritization of risks, (4) determination and implementation of control actions, and (5) evaluation and revision of actions and techniques, are equally applicable to the specific site of an emergency incident and to any off-site areas that may be impacted (directly or indirectly) by the known emergency.

Just as a comprehensive holistic approach to risk management requires consideration of both on- and off-site sources of hazard to the community and environment (Fig. 2.7), so does it require consideration of the potential implications of a particular incident on distantly located community resources

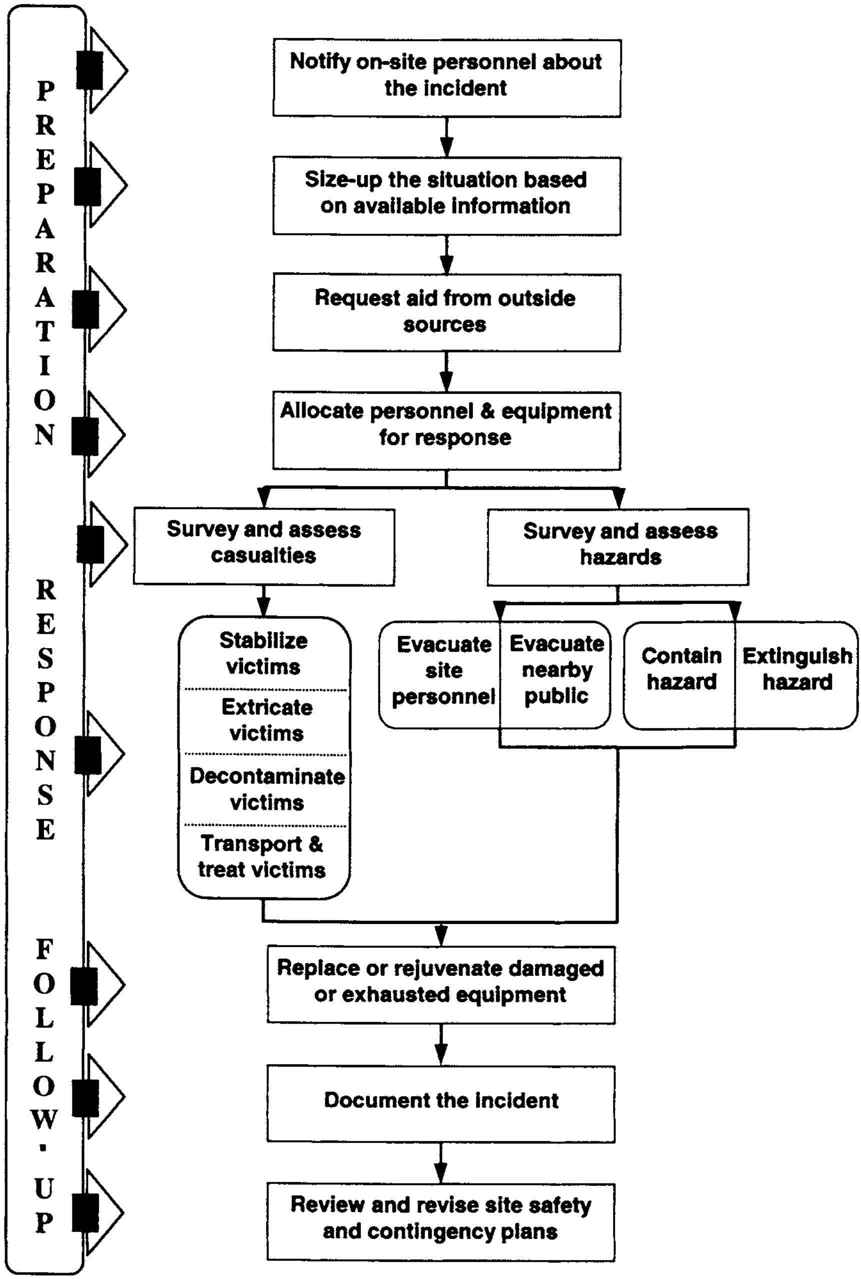

FIGURE 2.5 Basic types of emergency response operations.

TABLE 2.2 Checklist of Basic Issues to Be Addressed in Detail in Any Emergency Response Plan

1. Description of type of emergency and minimum information required
2. On- and off-site notification requirements
3. On- and off-site responsible personnel
4. Criteria for evaluating levels of emergency
5. Evacuation requirements
6. PPC/PPE by Task
7. Personnel Monitoring Requirements
8. Communication and Information Processing
9. On- and off-site control procedures
10. Emergency medical care and surveillance
11. Post-emergency actions and documentation

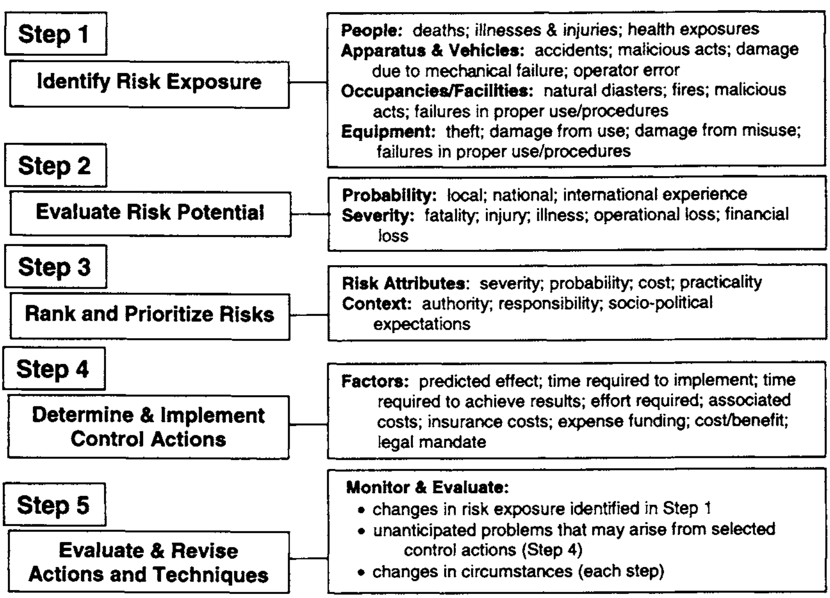

FIGURE 2.6 Five key steps in developing a risk management program (adapted from U.S. Fire Administration, 1966: Risk Management Practices in the Fire Service [FA-166]).

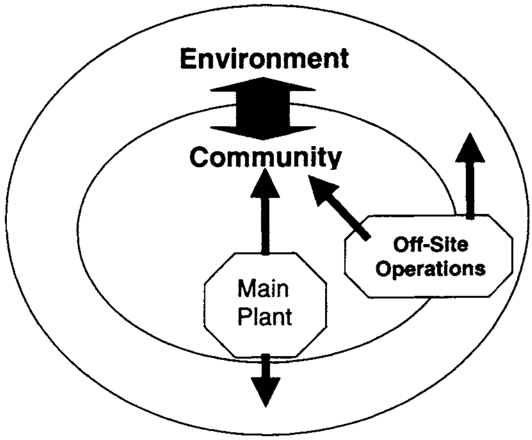

FIGURE 2.7 Direct and indirect risks to the community due to industrial on- and off-site operations. Indirect risks are due to impacts of incident on environmental resources (e.g., air, water) that can lead to subsequent exposures of the public to hazardous contaminants.

and dynamics. This approach is particularly important, of course, in cases of terrorism where one or more incidents may be planned primarily to draw attention away from a primary target. However, even where terrorism is not involved, any incident in one location can increase risks at other locations—as, for example, when an extensive fire in one part of the community leaves the rest of the community with reduced fire response capacity.

While the term *site control* typically refers to response activities undertaken on the site of (or in the immediate vicinity of) a specific incident, off-site management effort must be simultaneously directed not only to ensure the proper back-up of that on-going emergency response effort, but also to manage additional potential risks for the remainder of the community. Of the seven common sources of emergency response failure shown in Fig. 2.8, most (if not all) become evident in a particular site-specific response. As serious as these failures may prove to be in terms of any particular incident, their importance is greatly magnified in terms of the potential needs of effective off-site management.

For example, while the lack of an established chain of command may impede if not prevent effective and efficient response to a particular, site-specific incident, it almost guarantees the vulnerability of the rest of the community to even greater devastation through a well planned and coordinated sequence of terrorist acts.

Another example is when, due to the extent of a particular emergency that essentially depletes the response resources of an urban area, additional reserve resources must be temporarily drawn from surrounding communities

FIGURE 2.8 Common causes of failure in emergency response operations.

to deal with any additional potential emergency. Depending upon the training, experience, and technology of these reserve resources, they may not be able to deal effectively with additional emergencies that may occur during the interval of the ongoing emergency.

AUTHORITY AND RESPONSIBILITY

At the heart of any bureaucracy, whether explicitly stated or, as most often the case, only to be inferred from organizational structure, is the distinction between authority and responsibility—the first being, in essence, the right to exact the obedience of others while exercising the prerogatives of independent determination and judgment, while the latter is the duty or obligation to be met through the exercise of that authority. One implies the other and, in consequence, the concepts of authority and responsibility become intimately interconnected in both the enculturated expectations of everyday life and the more formal principles and doctrines that guide institutional behavior.

Of course, the marvel of all cultural traditions is that they are often easily "short-circuited"—modified to meet the demands of new experience or, as may often be the case, simply ignored. With regard to corporate attitudes toward health and safety risks, it would appear that the traditional sense of the need for a commensurate balance between authority and responsibly has much more frequently been purposely ignored than usefully modified.

Despite a growing number of exceptions, the corporate employee who is assigned programmatic environmental or health and safety responsibility (and, therefore, responsibility for in-house emergency response) is typically a low-level manager, supervisor, or technician who has little if any discernible authority over—or measurable influence on—key corporate decision-making or over any substantive planning or production-related process. In such a situation, it is not surprising that the so called "safety officer" usually becomes preoccupied with actual health and safety incidents and regulatory compliance failures rather than effectively managing a comprehensive health, safety, and emergency response program—or that the workplace continues to be the focus of governmental and social concern about community health and safety and environmental quality.

The only practical way by which to ensure that the authority of corporate safety officials is in fact commensurate with their responsibility is to extend that authority to whatever extent required for the effective managerial control of the sources of health and safety hazards and of all circumstances, including emergency planning and response, that may contribute to or be affected by potential human exposure to those hazards.

State-of-the-art companies today understand that this approach requires that significant health and safety responsibility, especially responsibility for emergency planning and response, be matched with high-level executive authority.

At the operational level of governmental agencies and community services, the concentrated effort to manage the diverse difficulties inherent in any bureaucratic structure of authoritative responsibility has been toward the implementation of the so called "Incident Command System" (ICS).

ICS is essentially a management system that can be used in any incident regardless of kind or size, including:

- Fires, HAZMAT incidents, and multicausal incidents
- Single and multiagency law enforcement incidents
- Multijurisdiction and multiagency disaster responses
- Search and rescue missions

- Oil spill response and recovery incidents
- Air, rail, water, or ground transportation accidents
- Planned events (e.g., celebrations, parades, concerts)
- Private sector emergency response

Capable of expansion or contraction, the ICS management system consists of five basic functions (Fig. 2.9), including (a) Command, (b) Operations, (c) Planning, (d) Logistics, and (e) Finance and Administration, which are equally pertinent to emergency planning and response undertaken either by governmental agencies or by private sector corporations.

Perhaps the most important of the key features of ICS (which is discussed in detail in Chapter 4) is that the individual designated as the Incident Commander (IC) has absolute responsibility for all functions, even if the IC chooses to delegate authority to perform selected functions to other persons. It is of vital importance, therefore, that *the adoption of ICS for emergency planning and response be undertaken only when the IC is provided absolutely clear and comprehensive authority and support necessary to achieve the objectives of emergency planning and support.*

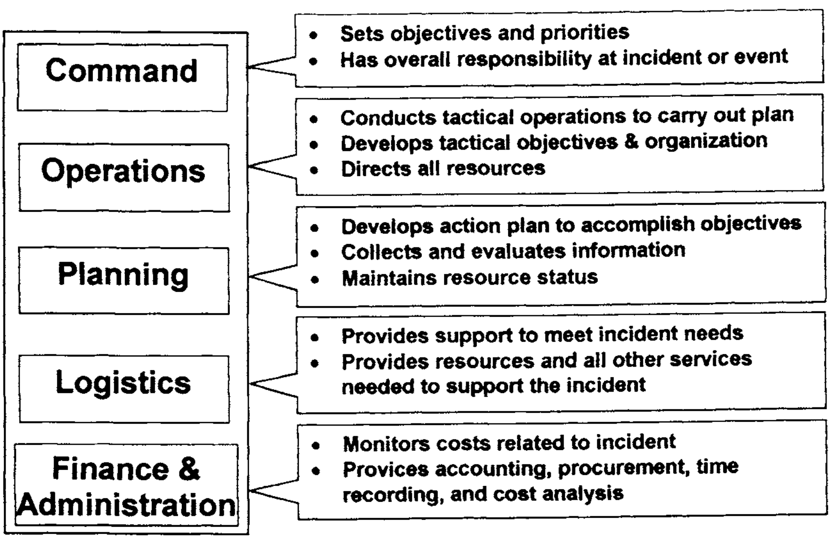

FIGURE 2.9 Duties and responsibilities of five major functional components of the incident command system (adapted from National Interagency Fire Center, 1994: Incident Command System National Training Curriculum, Module 3 [NFES No. 2443]).

COMMUNICATION AND INFORMATION HANDLING/PROCESSING

In both planning and response phases of emergency management, there must finally be reliance upon human judgment. While the soundness of human judgment can be assessed by various criteria that typically pertain to the specific person exercising judgment (e.g., range of practical experience, demonstrated theoretical expertise, flexibility of approach in different contexts), the essence of sound judgment becomes most often most clearly evident in the manner in which information is specifically and efficiently marshaled toward the actual achievement of objectives. In this sense, there can be no effective emergency planning and response without fastidious attention to communication and to information handling and processing, including the mechanical and electronic wherewithal as well as those components related to substantive content and format, software, and computerized databases.

Examples of key communication and informational needs for emergency planning and response include:

• Alarm and alert systems and devices (e.g., facility evacuation alarms; process control alarms; safety alert devices for SCBA ensembles; automatic notification of community fire, HAZMAT and rescue services; in-plant monitoring systems)

• Line, radio, and oral communication devices/procedures (e.g., inter- and intraresponse teams and units; incident command and community resources; public address and mass-media; communication reliability, security, redundancy, and backup)

• Chemical databases (e.g., on-site chemical inventories, chemical attributes, required personal protective clothing (PPC) and equipment (PPE), accepted disposal techniques)

• Computerized modeling (e.g., air dispersion models) and information retrieval systems (e.g., virtual reality systems for directed entry into buildings)

• Hardcopy information files (e.g. Material Safety Data Sheets, plant and responder personnel rosters, inventory of at-risk persons and resources in general area, location of access roads and entries, location of sensitive environmental resources, structural components and attributes of facilities, location of in-plant hazards)

In any particular incident, much of the information required for effective emergency response actually exists, but is either located or formatted in such a manner as to preclude its timely use. For example, Fig. 2.10 is an example of a chemical inventory containing information about a company's stock chemicals as required under U.S. OSHA Hazard Communication

Global Enterprises, Inc.
Chemical Inventory

Department	**Date**	**Authorization**
Quality Control Laboratory	July 19, 1996	Elizabeth Kohl

1, 3-Phenylguanidine

Route(s): Inhalation; Absorption; Surface Contact
Hazard(s): Irritant; Sensitizer; Toxic
Target Organ(s): Skin; Eye; Mucous Membranes; Respiratory Tract

2-Butoxyethanol

Route(s): Inhalation; Ingestion; Absorption; Surface Contact
Hazard(s): Combustible; Irritant; Toxic; Teratogen
Target Organ(s): Skin; Eye; Mucous Membranes; Kidney; Liver; Blood; Respiratory Tract; Reproductive System; Lymphatic System

2, 4, 6-Trichlorophenol

Route(s): Inhalation; Ingestion; Absorption; Surface Contact
Hazard(s): Irritant; Toxic; Carcinogen
Target Organ(s): Skin; Eye; Mucous Membranes; Respiratory Tract

Acetophenetidin

Route(s): Inhalation; Ingestion; Absorption; Surface Contact
Hazard(s): Irritant; Toxic; Carcinogen; Teratogen; Mutagen
Target Organ(s): Skin; Eye; Mucous Membranes; Lung; Kidney; Bladder; Respiratory Tract, GI Tract; Reproductive System; Nervous System

Ceric Ammonium Nitrate

Route(s): Inhalation; Ingestion; Surface Contact
Hazard(s): Oxidizer; Irritant; Toxic
Target Organ(s): Skin; Eye; Mucous Membranes; Respiratory Tract

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FIGURE 2.10 Sample page from a corporate chemical inventory that includes chemically specific health and safety information.

(29 CFR 1910.1200) and Laboratory (29 CFR 1910.1450) Standards. The format of information depicted in Fig. 2.10 would not typically be useful to an Incident Commander in the midst of an actual emergency. However, such information is most often computerized, and therefore the database could

easily be managed so as to produce, for example, a printed list of all flammable and corrosive liquids—a list that could be of immediate use to emergency response teams. The production and availability of such a printed list depend, of course, on *appropriate liaison between corporate officials and emergency responders prior to an actual plant emergency.*

PROVISIONS AND SUPPORT

In the vast majority of hazardous incidents, it is highly unlikely that sufficient supplies of material resources (provisions) or appropriate personnel (support) will be immediately available to meet the needs of emergency response—especially when that response requires highly specialized expertise, materials, or equipment, or when the incident involves potential risk to large numbers of people or extends over an extensive geographical area. Moreover, because even a seemingly small and well-contained incident may suddenly escalate to a major incident or develop in an unforeseen manner, it is necessary that emergency planning at both corporate and municipal levels includes detailed plans for obtaining, as necessary, provisions and support beyond those that are readily available and under the direct control of the incident commander. In this regard, emergency planning (and training) must be guided by the assumption of a *worst-case scenario* for the incident.

Just what constitutes the worst-case scenario for a potential incident cannot, of course, be precisely defined except in the specific context of an actual incident. However, certain categorical circumstances must always be considered, including:

- In-plant work-shift schedules (resulting in variable availability of personnel who can serve as initial responders)
- Holidays, local events (e.g., parades), and highway traffic congestion
- Severe weather conditions
- Concurrent disasters in local area (or region)
- Local or regional power failure
- Disruption of primary means of transportation
- Significant risk to large portions of the public
- Significant risk to environmental resources (e.g., public water supplies)
- Overwhelmed local medical treatment or temporary housing facilities
- Potential involvement of special facilities/populations (e.g., hospitals, schools, day-care centers, nursing homes)

Table 2.3 includes a variety of resources that may need to be obtained from external sources, including public and private sources. In addition to

TABLE 2.3 Potential Resources for Rescue Teams (Adapted from U.S. Fire Administration, 1995: Technical Rescue Program Development Manual [FA-159])

Supplier	Resource
Construction/heavy equipment companies; state and local public works agencies	Backhoes; cranes; air compressors; dewatering pumps; dozers; loaders; welders; bobcats; generators; cherry pickers; tractor trailers; lighting; heavy tools; cutting and breaching equipment
Rental companies	Light tools; lighting; generators; air compressors
Lumber yards	Lumber; cutting equipment
Association of Engineers	Civil engineers; electrical engineers; fire protection engineers
Communications	Television stations; radio stations; ham radio groups
Emergency equipment suppliers	Sandbags; hazardous waste removal firms; vacuum trucks
Schools, churches, Red Cross, food suppliers	Disaster centers; food; shelter
Funeral homes and medical examiners	Morgue services
Helicopter terminals	Medevac; rescues; aerial photography; personnel and supply transport
Military/National Guard	Personnel; equipment
Transport companies	Equipment and supply transport; refrigerated trucks
Utility companies	Utility shut-off
Bottled water companies	Bottled water

these sources, both municipalities and corporations should consider establishing formal *mutual assistance agreements* among local organizations to ensure the timely availability of necessary resources. This approach is particularly useful where there is a local concentration of similar or related industries, such as deep-water ports, technology parks, and industrial centers.

In addition to material resources, informational resources must also be identified and effectively integrated into the emergency planning process. Informational resources include public and private services of local, regional, national, and (increasingly) international scope (Table 2.4). While many of these services are organized on the basis of specific types of hazards (e.g., poisons, biological hazards, pesticides), a growing number of professional organizations provide and share information on the basis of specific types of industry (e.g., pharmaceutical manufacturers, electroplators).

At the local level, an important pool of valuable information and resources is available for purposes of emergency response planning through individual corporate plans (Table 2.5) already developed to meet specific regulatory requirements (e.g., Chemical Hygiene Plan, Hazard Communication Plan). In some nations, some of these corporate plans are required to be filed with community authorities. For example, in the United States, the

TABLE 2.4 Information Services (Adapted from U.S. Fire Administration, 1994: EMS Safety: Techniques and Applications [FA-144/April 1994])

Information Services

CHEMTREC
Tel: 800-424-9300
A private service providing information about chemicals involved in transportation accidents

ATSDR (Agency for Toxic Substances and Disease Registry)
Tel: 404-488-4100
A 24-hour service that provides toxicological information and HAZMAT incident guidance

CDCP (Centers for Disease Control and Prevention)
Tel: 404-633-5313
Provides information about biological and disease-related hazards

Local Poison Center
Regional centers that cover all regions in the United States

NPTN (National Pesticide Telecommunications Network)
Tel: 800-858-7378
A 24-hour service for information related to pesticide exposures and accidents

NRC (Nuclear Regulatory Commission)
Tel: 301-951-0550
A 24-hour service for information regarding radioactive materials

corporate contingency plan developed in compliance with U.S. EPA hazardous waste regulations must be made available to the local fire chief and other authorities (including corporate-designated medical facilities). However, regardless of specific regulatory requirements regarding coordination with local authorities, most corporations develop extensive information and detailed plans that, if made more generally available, would significantly expand local emergency response capacity. The sharing of such information and related material resources beyond the requirements of individual laws and regulations is probably most feasible through individual mutual assistance agreements among corporations as well as between corporations and local community authorities.

MEDICAL TREATMENT AND SURVEILLANCE

In any incident, there are several distinct groups of potential victims that must be considered for possible medical treatment and surveillance:

TABLE 2.5 Example of Table of Contents for Corporate Chemical Hygiene Plan Pursuant to 29 CFR 1910.1450

Chemical Hygiene Plan
Table of Contents

1. Introduction

2. Responsibility

3. Standard Operating Procedures (general)
   - Personal Preparation & Behavior
   - Preparation of Work Area & Equipment
   - Maintenance of Work Area
   - Emergencies
   - Ordering Chemicals
   - Receiving Chemicals
   - Transporting Chemicals
   - Storing Chemicals
   - Using Chemicals
   - Using Extremely Hazardous Chemicals

4. Standard Operating Procedures (Chemically Specific)
   - Compressed Gases
   - Corrosive Chemicals
   - Flammable Chemicals
   - Extremely Hazardous Chemicals
   - OSHA Listed Chemicals

continues

• On-site victims (i.e., persons who are present on-site at the time of the incident and who are immediately at risk)

• On-site emergency response personnel (i.e., initial or subsequent responders who, though prepared to respond to the emergency, are nevertheless subject to risk; this group includes firefighters, HAZMAT and other specialized (e.g., EMT) teams

• Off-site emergency response personnel (personnel who, though off-site, may be at risk due to contamination (chemical/biological) of evacuated victims (e.g., hospital personnel, ambulance personnel) or to fugitive toxic fumes/particles

• Off-site general public (any other off-site person who may become at risk due to air or water contamination directly or indirectly related to the incident, through contact with similarly contaminated persons, or through contact with facilities used as temporary shelters/housing for contaminated victims)

TABLE 2.5—*continued*

Chemical Hygiene Plan
Table of Contents (continued)

5. Methods for Limiting Exposure
   - Engineering Controls
   - Fume Hood Inspection
   - Personal Protective Clothing & Equipment
   - Emergency Equipment
6. Availability of Data & Information
7. Personnel Training
8. Medical Surveillance
   - Exposure Determination
   - Methods of Surveillance
   - Documentation
9. Determination of Health Hazards
   - Acute Hazards
   - Chronic Hazards
10. Special Issues
    - Prior Approval for New Chemicals
    - Chemicals Generated in Laboratory

Appendices

Historically, emergency response planning has typically focused on providing on-site victims the medical treatment and surveillance appropriate for acute physical injury and psychological trauma. However, it has become increasingly evident (especially with respect to terrorism) that treatment and surveillance related to chemical and biological contamination of both on- and off-site victims are critical, and demand equal regard for acute and chronic injury and disease.

Even in the absence of terrorism, the increasing global dependence on industrial chemicals and the rapid development of biotechnology increases the probability that industrial incidents will result in increasing numbers of the general public being at risk due to dangerous chemical and biological exposure. In this sense, our historic experience with providing medical treatment to large populations simultaneously subjected to the geographically extensive acute risks of storms, floods, and earthquakes provides limited instruction for providing medical treatment and surveillance to large populations simultaneously subjected to both the acute and the chronic hazards of chemical and biological agents.

REMEDIATION AND REVIEW

Whatever the operational or even regulatory definition of an emergency response incident, the actual incident is multidimensional, consisting of (a) preceding events, (b) the primary event that precipitates emergency response, (c) all actions taken during the response effort, and, finally, (d) all circumstances resultant from the response effort.

Remediation is inclusive of all actions undertaken during and after the response effort (c and d, above) to minimize harm and injury due to the secondary effects of the emergency. For example, the incident may be essentially defined as a structural fire; however, runoff water resultant from fighting that fire may contain toxic chemicals, and remedial actions must be taken to contain and properly dispose of that contaminated water. Also, it may be necessary to demolish remaining structures that may have become unsound.

With similar regard for managing risk both during and after the incident, it is incumbent upon the emergency planner to consider a wide range of additional issues, including:

- Off-site management of crowds and management that might not only interfere with the specific response effort, but also result in other public and personal risks
- Implementation of facility and local community evacuation
- Assessment of injuries and allocation of victims to first-aid and subsequent medical treatment
- Decontamination of personnel, equipment, materials, and facilities that may have become contaminated during the emergency response
- Containment and ultimate disposal of contaminated soil, water, structural and inventory materials
- Preservation of scene for subsequent criminal investigation
- Recharge and/or replacement of exhausted, damaged, or proven-inadequate emergency response materials, supplies, and equipment
- Documentation of all response efforts
- Documentation of possible exposures of response personnel (for use in subsequent long-term medical surveillance of response personnel)
- Retraining of personnel in light of actual response performance
- Review and revision of existing emergency response plans and response procedures in light of the incident

Perhaps the major difficulty in ensuring a comprehensive assessment of remediation and review efforts is that, in an actual incident, various authorities (including corporate and public personnel) play diverse roles and are subject to different jurisdictional constraints. From the perspective of corporate and municipal managers, it is therefore essential (a) to conduct a comprehensive and intensive postincident debriefing of all responding agencies and authorities, and (b) to integrate resultant findings, information, and recommendations into subsequent emergency response planning and training activities.