HAZARDOUS MATERIALS

RISK ANALYSIS

Introduction to Risk Analysis, 1

Overview of Training, 3

Federal Guidelines, 4

Overview of Emergency Planning, 7

Hazards Analysis, 11

Risk Analysis, 13

Conducting a Risk Analysis, 15

Advanced Techniques, 21

A relative ranking of hazards for the purposes of community emergency planning does not require extensive mathematical evaluations, application of statistics, or extensive support from experts. Application of readily available information and common sense, when combined with site-specific evaluations such as the vulnerability analysis, will complete much of the risk analysis process.

. . . Technical Guidance for Hazards Analysis

INTRODUCTION TO RISK ANALYSIS

hazardous materials preparedness

The economic vitality of American industry depends on the manufacture, transportation, storage, processing, and disposal of an increasing volume of hazardous materials--substances that are flammable, poisonous, radioactive, corrosive, or explosive. To protect the public from an accidental release of these chemicals, local jurisdictions must be prepared to deal with hazardous materials emergencies, whether on the nation's highways or at fixed-site facilities in the area.

emergency planning

For this reason, communities and businesses develop plans designed to identify the risks posed by different hazardous substances. These plans attempt to answer questions like:

* How dangerous are the routine emissions of a local plant to people in surrounding neighborhoods?
* How likely is a spill of hazardous materials on the major highway through the community?
* If an accident occurs on the highway or in the plant, how many people will be hurt? What are the long-term health consequences?
* Which hazard poses a greater threat to the community (and should be considered first in planning)--the highway or the plant?

definition of risk analysis

A study that answers questions like this is called a **Risk Analysis,** one component of a comprehensive hazardous materials emergency plan. ***A risk analysis is an evaluation by the community of the likelihood of an accidental release of hazardous materials and the expected consequences of such a release.*** Specifically, it provides an estimate of:

* The probability of an accidental release, (and the possibility of simultaneous emergency incidents)
* The severity of human injury or death that would result
* The consequences for special facilities (e.g., hospitals, nursing homes, prisons, communication centers)
* Expected damage to property and the environment

benefits of risk analysis information

This information is extremely valuable to emergency planners and decision-makers. In particular, the results help communities establish planning and allocation priorities that target limited resources to the most significant threats. In addition, a thorough risk analysis provides a foundation for educating senior government officials and the public on the dangers posed by various chemical hazards.

focus of training

This document presents a brief overview of a very complex topic: community risk analysis. It is designed to familiarize you with related concepts and techniques, but not to provide a detailed "how to" manual for emergency planners. For more information, review other sources listed in Appendix A or seek additional assistance, as needed.

Although many of the same principles apply in other emergency management disciplines, the focus here is on risk analysis for hazardous materials preparedness. The approach follows guidelines developed by the National Response Team, composed of representatives of 14 federal agencies. Individual communities, however, may wish to adopt other approaches, depending on their information needs and technical resources.

OVERVIEW OF TRAINING

TRAINING GOAL

Promote an awareness and understanding of the basic concepts and principles of risk analysis.

Provide an understanding of related methods and tools.

Motivate the adoption of effective practices at the state and local levels.

TRAINING AUDIENCE

Government officials and others with a responsibility for hazardous materials emergency management and planning.

TRAINING OBJECTIVES

At the conclusion of training, you should be able to accomplish the following:

- Define "risk analysis" and discuss its importance in environmental and emergency management.
- Identify common applications and benefits of risk analysis in hazardous materials emergency management.
- Explain the basic risk analysis process; discuss limitations of quantitative risk analysis and hazards analysis.
- Describe general risk analysis requirements and methods for fixed facilities and transportation routes.
- Identify common problems and cite generic guidelines for conducting risk analyses.
- Determine your requirements for further information or training, and list possible sources.

FEDERAL GUIDELINES

FEMA REQUIREMENTS

emergency operations plans

Planning requirements for jurisdictions receiving FEMA funds call for states and local governments to prepare an emergency operations plan (EOP). Jurisdictions must identify available personnel, equipment, facilities, supplies, and other resources, and specify the method for coordinating actions by individuals and government services in an emergency. The plan should address planning needs at all levels of government, for all types of hazards, and in all phases of emergency management.

Guidance on the form, content, and development process for state and local emergency plans is contained in various FEMA publications, including:

CPG 1-8

* Guide for Development of State and Local Emergency Operations Plans

CPG 1-8a

* Guide for the Review of State and Local Emergency Operations Plans

CPG 1-35

* Hazard Identification, Community Assessment and Multi-Year Development Plan

These documents present the fundamentals of *all-hazard* planning; they are not concerned specifically with hazardous materials. Furthermore, the subject of risk analysis is not specifically addressed, although it is part of the hazardous materials appendix of a multi-hazard EOP.

SARA **TITLE III**

hazardous materials legislation

Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) is also called the *Emergency Planning and Community Right-to-Know Act. The* legislation has two main purposes:

* to encourage and support emergency planning and response for chemical accidents

* to provide local governments and the public with information about possible chemical hazards in their communities.

the value of information

SARA provides a mechanism to ensure that local governments and individual citizens have the information they need to plan for and take protective actions in the event of a hazardous materials incident. The law assumes that the more people know, the better equipped they will be to protect their families and neighbors from unacceptable risks associated with hazardous materials.

reporting requirements

To make available the information needed for this job, Title III requires companies--both manufacturers and non-manufacturers--to publicly report the amount, location, and potential effects of hazardous materials being used or stored at their facility. The law has four basic requirements:

1. **Emergency planning.** Facilities that store or use any of more than 300 Extremely Hazardous Substances (EHSs) report this fact to the Local Emergency Planning Committee (LEPC), which develops an emergency plan based on this and other information.

2. **Emergency release reporting.** Facilities must report accidental releases of EHSs in amounts over a designated reporting threshold.

3. **Hazardous chemical reporting.** Facilities that store or use any hazardous chemical in amounts over certain reporting thresholds must submit an annual chemical inventory list to the LEPC and State Emergency Response Commission (SERC).

4. **Creation of an emissions inventory.** Manufacturing facilities that use any of a different list of about 300 chemicals must report emissions in greater than threshold quantities to EPA and designated state agencies.

SARA Title III and risk analysis

SARA Title III establishes a requirement for state and local jurisdictions to develop hazardous materials emergency plans. The legislation also specifies a mechanism, process, and related responsibilities for planning. Perhaps most importantly, SARA, through its facility reporting provisions, helps ensure that adequate information is available to the community for planning purposes.

technical guidance

As part of SARA, Congress mandated that the National Response Team provide guidance on preparing and reviewing emergency plans. This guidance, which addresses a recommended approach to risk analysis, is contained in publications available to state and local officials, including:

* NRT-1: Hazardous Materials Emergency Planning Guide
* Technical Guidance for Hazards Analysis
* Handbook of Chemical Hazard Analysis Procedures

OTHER INFORMATION SOURCES

related resources

Related information and assistance can be found in a variety of sources, some of which are listed in Appendix B. A complete discussion of the legislation, programs, and materials listed is beyond the scope of this training. However, you are encouraged to consider these resources, depending on your specific interests and needs.

OVERVIEW OF EMERGENCY PLANNING

As noted previously, SARA Title III requires each community to prepare a comprehensive hazardous materials emergency plan. The benefits of planning include:

benefits of planning

* An orderly, systematic approach to decision-making
* A mechanism to communicate and document the results of decisions
* A baseline for evaluating options and emergency actions

A **risk analysis,** in which planners evaluate the probability and consequences of possible hazardous materials events, is an important component of the plan. Therefore, the objectives and methodology for preparing a risk analysis must be viewed in the context of the overall plan.

THE PLANNING PROCESS

SARA Title III calls for a clearly ***defined approach to planning and a written plan.*** Minimum requirements for the plan include:

minimum requirements

* Identification of facilities and extremely hazardous substances, transportation routes, and additional facilities at risk or that could contribute to additional risk
* Private and public sector emergency response procedures, on-site and off-site
* Designation of a community coordinator and facility coordinator(s) to implement the plan
* Emergency notification procedures
* Methods for determining the occurrence of a release and the probable affected area and population

minimum requirements (continued)

- Description of community and industry emergency equipment and facilities and the identity of persons responsible for them
- Evacuation plans
- Description and schedules of a training program for emergency response personnel
- Methods and schedules for exercising emergency response plans

planning is an ongoing process

But planning is a process, not simply a document. In developing the plan, members of the community work together to identify problems, determine priorities, allocate resources, assess capabilities, and so forth. No single approach is appropriate for all jurisdictions.

two planning formats are possible

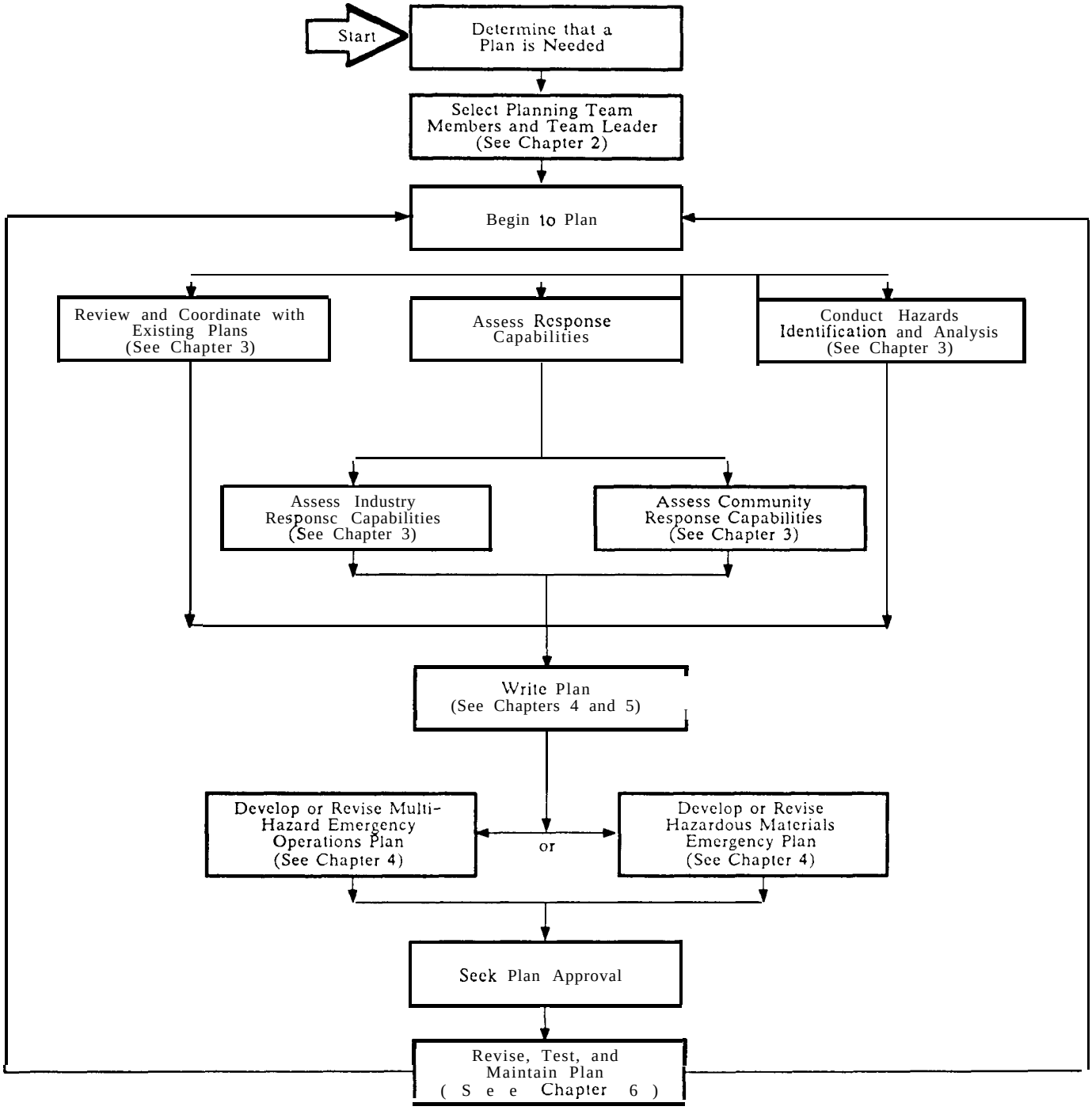
Hazardous materials emergency plans can be prepared as part of the community's multi-hazard Emergency Operations Plan (EOP) or as a separate stand-alone document. (Communities receiving FEMA funds are required to incorporate hazardous materials planning into their EOP. Other communities are encouraged to do so.)

COMPONENTS OF **THE PLAN**

Although each community tailors the planning process to its specific needs and constraints, plans should address certain basic requirements. Figure 1, taken from NRT-1, depicts an general overview of the planning process.

Figure 1

OVERVIEW OF PLANNING PROCESS



For our purposes, three primary tasks can be identified:

step 1

* Review of Existing Plans--The first step in emergency planning is to review existing plans prepared by individual facilities, communities, the state, Regional Response Team, and the federal government. This step is designed to minimize redundant efforts by avoiding "recreating the wheel." The analysis is also necessary to ensure coordination with other groups.

step 2

* Hazards Analysis--During this stage, planners identify where and how hazardous materials accidents could occur and the nature of the threat they pose. The study provides a factual basis for planning and response efforts through a detailed analysis of hazards specific to the community.

step 3

* Capability Assessment--Planners next develop a realistic evaluation of the community's ability to prevent or respond to potential accidents identified in the hazards analysis. Both community and industry response capabilities are considered. Factors include existing plans, mitigation measures, resources, and legal authorities.

developing the plan

The analyses conducted during these three phases provide a solid foundation for developing the emergency plan. The final planning process is as much an art as a science, requiring the close integration of people, organizations, and resources.

Remember: emergency planning is never complete; the plan should be considered a "living document" that must be continually refined to meet changing needs and conditions.

HAZARDS ANALYSIS

A systematic and thorough hazards analysis is a necessary step in the development of emergency plans. The analysis identifies all possible threats and vulnerabilities, presents historical data about past disasters, assesses future probability and frequency of emergencies, and validates gathered data. Considerations include the predictability, frequency, controllability, duration, scope, and intensity of hazards.

There are three basic steps in conducting a hazards analysis:

what is the threat?

1. Hazards Identification--The purpose of a hazards identification is to provide information on the identities and quantities of hazardous materials in the community; the location of facilities that use, produce, process, or store hazardous materials; the physical and chemical properties of the substances; storage conditions; transportation routes; and the nature of associated hazards.

what areas may be affected?

2. Vulnerability Analysis--When conducting a vulnerability analysis, planners identify the geographic zone of the community that may be affected by the release of a hazardous substance; the population within each zone that is subject to harm; critical facilities (for instance, hospitals) that are at risk; and property and environmental systems that may be damaged.

how significant is the risk?

3. **Risk** Analysis--A risk analysis provides a means to judge the relative likelihood of a release, and the magnitude of harm to humans should one occur. The analysis includes 1) a judgment of the probability of the release; 2) a judgment on the severity of consequences; and 3) a basis for comparing sites to establish priorities for emergency planning.

planners should limit the scope of the analysis

Preparing a community hazards analysis is a big job, especially in large jurisdictions with thousands of chemical threats. While a complete analysis of all hazards would be informative, it may not be feasible or practical given resource and time constraints. Therefore, a hazards analysis may include vulnerability and risk analyses, or may simply identify the nature and location of hazards in the community. For similar reasons, communities usually conduct an initial screening process in order to limit in-depth analysis to the most important hazards.

It is critical for planners to determine how detailed an analysis to conduct. But whether simple or sophisticated, the analysis should serve to characterize the nature of the problem posed by hazardous materials. This information can then be used to orient planning to the community's unique situation.

using the results

Some information from the hazards analysis can be incorporated directly into the emergency plan, but results are useful in other ways as well. For example, knowledge of the hazards associated with a particular substance can help local officials set planning priorities or determine whether specialized response equipment or training is needed. The characteristics of the vulnerable zone helps planners assess warning systems, identify evacuation routes, and estimate requirements for temporary shelter and food.

Can you think of other uses for the information developed during a hazards analysis?

STUDENT NOTES:

RISK ANALYSIS

The third step of the hazards analysis process, risk analysis, builds on the results of the previous two (hazard identification and vulnerability analysis). A ***risk analysis is designed to provide a means for emergency planners to evaluate and compare different risks by assigning a measure to hazards and ranking them.***

setting priorities

Since, ideally, the community should prepare for all potential hazards--whether large or small--a risk analysis is conducted primarily to set planning priorities. This purpose is particularly important where time or resource constraints prohibit an in-depth planning effort on every possible hazard.

THE ANALYTICAL PROCESS

ranking hazards

For example, let's assume you have identified that a local facility uses an extremely hazardous substance, say aldicarb, in quantities large enough to pose a risk to surrounding neighborhoods. You have investigated the hazard, calculated the corresponding vulnerable zone around the plant, and estimated the populations that would be affected by a release.

Now you need to know: How ***dangerous is this hazard compared to others in the community?***

Whether for fixed facilities or transportation routes, a similar general approach can be applied:

the risk analysis process

* Use credible worst case assumptions from the vulnerability analysis for each hazard
* Collect all information from the hazards identification and vulnerability analysis into a table
* Obtain additional information on community and facility safeguards, response capabilities, and accident records

risk analysis process (continued)

* Make a judgment on the probability of a release
* Make a judgment on the severity of consequences of the release
* Organize the results in a matrix format designed to help you rank the risks

qualitative and quantitative measures

Probability and severity can be measured in qualitative terms (high, medium, low) or in quantitative terms using numerical estimates and statistical calculations where resources permit. The level of detail might vary from plan to plan and even among different hazards. In practice, a local risk analysis may be based on common-sense evaluations by knowledgeable members of the planning team. More sophisticated means are available (see Advanced Techniques) but are not considered essential for emergency response planning.

different results are possible

It is important to remember that even a quantitative risk analysis relies on judgments, assumptions, and simplifications. Results will vary based on many factors, including local priorities and resources. However, a risk analysis provides a systematic approach for evaluating complex phenomena, and a method to apply the results for emergency decision-making. A well-designed process also helps planners and others:

* Conceptualize and understand hazards faced by the community
* Identify possible mitigation measures
* Document results of the decision-making process
* Communicate about risks with officials and the general public

CONDUCTING A RISK ANALYSIS

There is no one right way to go about conducting a risk analysis. The approach chosen by the community will depend on the hazard, existing information, and available resources.

DATA GATHERING

Since the characteristics of hazards vary significantly, different types of information may be useful in evaluating the likelihood and severity of a release. Important sources include (for a more detailed list, see Appendix I from the publication Technical Guidance for Hazards Analysis):

types of information useful for risk analyses

* Existing community response plans
* Existing facility safety and response plans and notification procedures
* Safeguards in place on-site; engineering control methods; leak and spill detection systems
* Equipment available on-site for emergency response
* Historical accident records
* Changing factors affecting future incidents; trends
* Handling procedures for hazardous substances
* Plant security, training, and public education programs
* "State-of-the-art" practices for similar facilities

sources of risk analysis information

Information can be gathered from a variety of sources appropriate to the specific hazard. For example:

* **The** data available through SARA Title III facility reporting requirements can be particularly useful.

* Local organizations--fire, police, hospitals, universities, news media, etc.--are a valuable source of information and expertise for the analysis.

* Assistance is available from national associations like CHEMTREC, the National Fire Protection Association, and chemical industry groups.

* Federal agencies with hazardous materials responsibilities provide guidance, software, and other resources.

working with individual facilities

Perhaps the most important source of information is the facilities themselves, which are required by law to provide all data "necessary for developing and implementing the emergency plan." Industries can and should be approached with questions regarding site-specific hazards and safeguards, and requests for assistance.

But remember that interaction with facilities should be based on cooperation, respect for trade secrets, and other confidential business information, and recognition of the industry as a member of the community.

avoid overly complex approaches!

As previously noted, an exhaustive data gathering process is usually not required to develop a relative measure of risk. Collection of data on all possible topics would be extremely complex and time-consuming. Therefore, it is important to recognize when enough information is gathered. The use of community-specific checklists can be helpful for this purpose.

ASSEMBLING THE INFORMATION

organize the information in a table format

Data collected during the three major steps of the hazards analysis should be systematically assembled as they become available. One method is to organize the information in a table format, with each hazard occupying one column. By placing all this material in a relatively abbreviated format, the table provides a direct way to identify missing information and to compare hazards with one another.

Figure 2, taken from the publication Technical Guidance for Hazards Analysis, presents a sample table.

present the information to community decision-makers

This information is then presented to community decision-makers, who evaluate the relative risk posed by each hazard. There are no hard and fast rules for determining relative risk. One type of hazard may have the potential for extensive damage, but the likelihood of its occurring is less than another which-would be less damaging. Subjective and qualitative judgments must be made in accordance with the information available.

use a matrix to rank risks from different hazards

To determine a relative ranking among risks, the responses of decision-makers are gathered into a risk analysis matrix. Steps in this process are as follows:

* Each hazard is assigned a rating based on the probability of a release. The rating can be in qualitative or quantitative terms.

* Each hazard is also assigned a value according to the severity of potential consequences, using a similar rating scheme.

* The results of these steps are combined in a matrix, similar to the one presented as Figure 3. The rating for "probability" is shown on the vertical or "Y" axis, and the rating for "severity" is shown on the horizontal or "X" axis.

Figure 2

EXAMPLE HAZARDS ANALYSIS MATRIX FOR A HYPOTHETICAL COMMUNITY

12 87

	Hazard A	*Hazard B*	*Hazard C*
INITIAL SCREENING			
1. HAZARDS IDENTIFICATION (Major Hazards)			
a. Chemical	Chlorine	Ammonia	Liquid methyl isocyanale (MC)
b. Location	Waler treatment plant	Tank truck on local interstate highway	Pesticide manufacturing plant in nearby semi-rural area
c. Quantity	800 bs.	3000 lbs.	1000 lbs.
d. Properties	Poisonous; may be fatal if inhaled. Respiratory conditions aggravated by exposure. Contact may cause bums b skin and eyes. Corrosive. Effects may be delayed.	Pdsonous; may be fatal if inhaled. Vapors cause irritation of eyes and respiratory tract. Liquid will burn skin and eyes. Conlacl with liquid may cause frostbile. Effects may be delayed. Although not flammable, will bum wilhin certain vapor concentration limits and increase fire hazard in the presence of oil or combustible materials.	Causes death by respiratory distress after inhalation. Other effects would include permanent eye damage, respiratory distress, and disorientation. Explosive. Extremely flammable.
2. VULNERABILITY ANALYSIS			
a Vulnerable zone'	A spill of 800 bs. of chlorine from a storage tank could result in an area of radius greater than 10 miles where chlorine gas may exceed the level of concern (LOC). This would be a credible worst case scenario.	A spill of 3000 lbs. of ammonia resulting from a collision of a lank truck could result in an area of radius 7.6 miles where ammonia exceeds its LOC. This would be a credible worst case scenario.	A spill of 1000 bs. of methyl isocyanale could affect an area of radius 7 6 miles with MIC vapors exceeding the LOC (assuming thal tie liquid is hot when spilled, the lank is not diked, and the MIC is al 100% concentration). Thii would be a credible worst case scenario
b. Population within vulnerable zone	Approximately 600 residents of a nursing home; workers at a small factory; 29 workers al the water-treatment plant; urban area-400 person&q. mile; total population in vulnerable zone is more than 125.000.	Up lo 700 persons in residences, commercial establishments or vehicles near highway interchange; seasonal influx of visitors b forest preserve in the fall; rural area-75 persons/sq. mile; total populario in vulnerable zone is 13,600.	Up to 200 workers at the plant and 1000 children in a school; rural area85 persons/sq. mile; total population in vulnerable zone is 15. 400.
c. Essential services within zone	2 fire stations and 1 hospital	1 volunteer Ire station	None
3. RISK ANALYSIS (Initial Evaluation of Reporting Facilities-Relative Hazards)	Relative lo potential hazards of other reporting facilities–high	Medium	High

'The distances here may not correspond wilh those in NRT-1 as the assumptions used in the calculation are different.

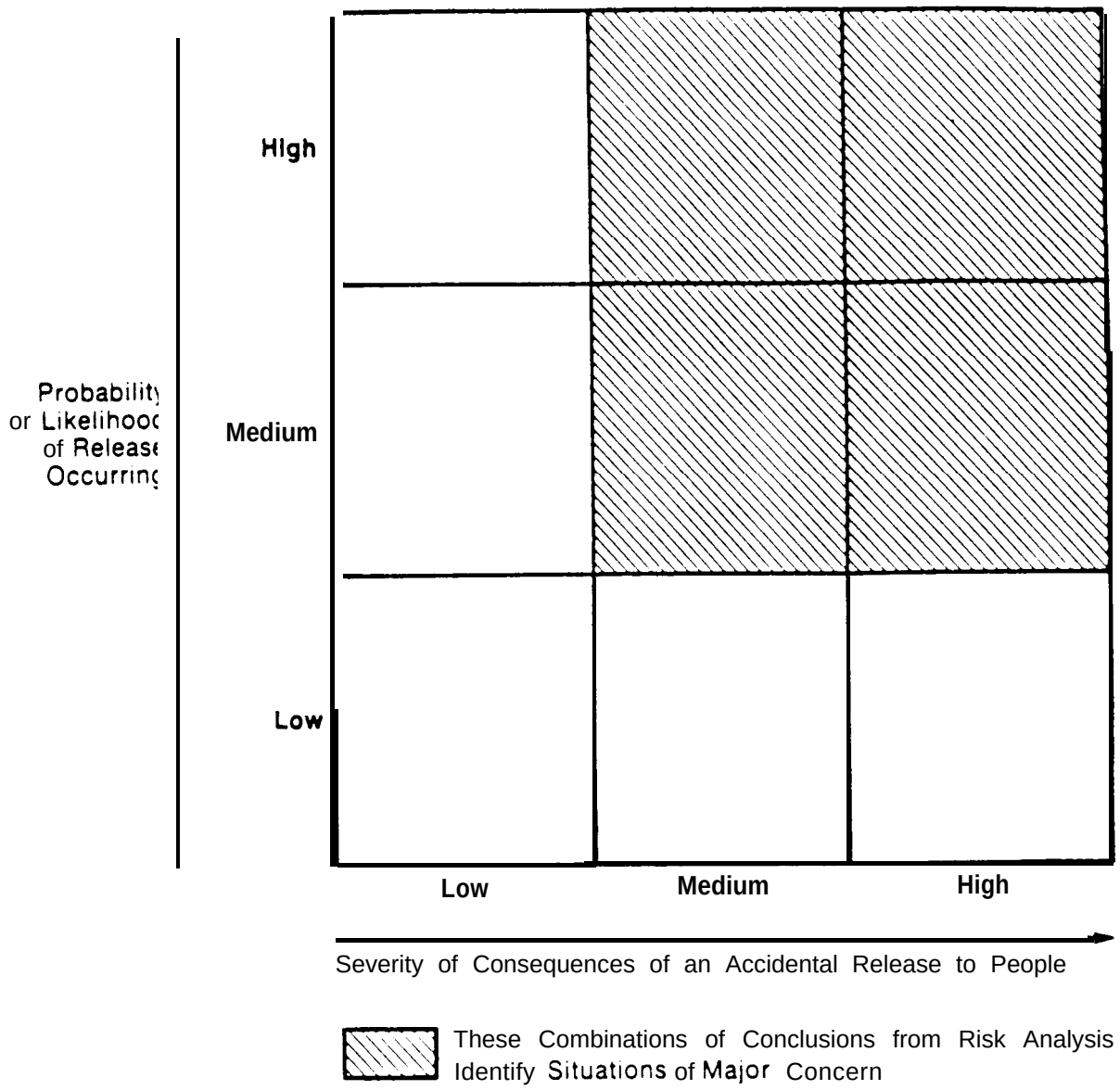
18

Figure 2 (continued)

	Hazard A	*Hazard B*	*Hazard C*
REEVALUATION		(Select facilities by priority based on initial screening)	
1. HAZARDS IDENTIFICATION			
a. Chemical	Chlorine	Ammonia	Liquid methyl isocyanate (MIC)
b. Location	No change	No change	No change
c. Maximum quantity that could be released	500 lbs. (decrease)	No change	1500 lbs. (increase) due lo increased production
d. Properties	No change	No change	No change
2. VULNERABILITY ANALYSIS			
a Vulnerable Zone	Zone decreases (new radus-1.0 miles) due lo smaller quantity released and use of urban dispersion model.	No change	Zone increases (new radius-greater than 10 miles) due b larger quantity released.
b. Population within vulnerable zone	Decreases; total population in vulnerable zone is 1250.	No change	Increases; total population in vulnerable zone is 26,700 including 200 workers at the plant and 1000 children in school.
c. Essential services	None	No change	1 fire station and 1 police station
3. RISK ANALYSIS			
a. Likelihood of hazard occurrence	Low-because chlorine is stored h an area with leak detection equipment h 24 hour service with alarms. Protective equipment is kept outside storage room.	High-highway interchange has a history of accidents due lo poor visibility of exits and entrances.	Low-facility has up b dale conlahmenl facilities with leak detection equipment and an emergency plan for its employees. There are good security arrangements that would deter tampering or accidents resulting from civil uprisings.
b. Consequences ii people are exposed	High levels of chlorine gas in he nursing home and factory could cause death and respiratory distress. Bedridden nursing home patients are especially susceptible. High severity of consequences. However, gas is unlikely lo reach a nursing home under reevaluated release conditions.	Motorists' reactions b release vapors may cause traffic accidents. Injured and trapped motorists are subject b lethal vapors and possible incineration Windblown vapors can cause respiratory distress for nearby residents and business patrons. High severity of consequences.	If accident occurs while school is in session, children could be killed, blinded and/or suffer chronic debilitating respiratory problems. Plant workers would be subject lo similar effects al any time. High severity h school hours, medium severity al all other times.
c. Consequences br property	Possible superficial damage lo facility equipment and structures bom corrosive fumes (repairable).	Repairable damage b highway. Potential destruction of nearby vehicles due b fire or explosions.	Vapors may explode in a confined space causing property damage (repair*). Damage could result from fires (repairable).
d. Consequences of environmental exposure	Possible destruction of surrounding fauna and flora.	Potential br fire damage to adjacent forest preserve due b combustible material (recoverable in the long term).	Farm animals and other fauna could be killed or develop health effects necessitating their destruction of indirectly causing death
e. Summary: likelihood/ seventy of consequences	Low/High The community would assess this on site and incident specific basis.	High/High. The community would assess this on site and incident specific basis.	Low/High lo medium. The community would assess Ihii on site and incident specific basis

Figure 3

RISK ANALYSIS MATRIX



Other rating schemes are also possible

This matrix permits nine possible rankings, based on high, medium, or low ratings for each variable. In general, the greater the estimate of probability and severity, the greater the estimate of risk. However, communities will need to evaluate if other factors not included in the rating process should be considered in the relative ranking of risks.

ADVANCED TECHNIQUES

The qualitative matrix method just discussed is adequate for most hazardous materials planning purposes. However, where sufficient information needs and resources exist, more advanced methods may be appropriate. This section briefly discusses the use of models and computers for hazards analysis (including risk analysis), and mentions several other techniques employed by industry to evaluate hazards.

ANALYTICAL MODELS

models provide a framework for analysis

Models are analytical tools that provide a structured framework for data gathering, and define procedures for calculations needed to evaluate hazardous materials threats. By constructing a simple representation of the situation, models attempt to simulate the outcome that can be expected under certain sets of conditions (scenarios). Decision-makers can then interact with the model by altering the conditions. In this way, they use the model to test the results of different assumptions or decisions.

using models for emergency management

Models can help emergency planners in a variety of ways. For example, given data about the amount and characteristics of a specific chemical, a model can be used to calculate toxic gas concentrations and determine vulnerable zones downwind of the site. The planner can then graphically superimpose the results on a map of the community.

Other models can help emergency managers determine evacuation routes by considering such factors as traffic flow rates, collector and arterial capacity, and alternative network configurations. Still others can be used to estimate the probability of occurrence of a hypothetical event. FEMA, EPA, and DOT have developed a model to simplify the analysis of hazardous materials risks associated with transportation incidents in communities whose population is less than 50,000 (see Appendix A).

benefits of models

Models facilitate the analysis process by, for example, providing data gathering forms and procedures, tables and charts used for calculations, analytical methods for quantifying risk, and instructions for using the results. Perhaps most importantly, models help eliminate biases or shortcuts by imposing a defined analytical methodology on the decision-making process.

limitations of analytical models

It is important to note, however, that models are valuable tools, but they have their limitations. First, models are simplifications of complex situations that may not capture all variables of interest to the decision-maker. Models may also reflect existing deficiencies in scientific understanding, data, or methods. And they typically rely to some degree on the assumptions, judgments, or priorities of the designer or user. As a result, it is not uncommon to find substantial variations when applying different models to the same problem.

USING COMPUTERS FOR HAZARDS ANALYSIS

Like models, computers are tools that can assist in calculating and reporting the results of a hazards analysis. They accomplish this function primarily through their ability to store, retrieve, and manipulate large volumes of data quickly.

benefits of computers

Automated systems have many advantages. For example, users can more easily sort data and select information according to specific criteria, or to join data bases for special needs. Managers can ask "what if' questions--determining how outcomes will change when parameters are modified--or run sophisticated analytical models. Computers can also aid in displaying the results, whether in narrative reports or using graphics and maps.

For conducting a risk analysis, planners can, for example, use computers to:

using computers for risk analysis

* Record pertinent information about chemicals and facilities

* Calculate vulnerable zones based on worst case assumptions
* Plot the results on a computer map showing the population and critical facilities
* Allow local decision-makers to record their judgments on the likelihood and consequences of different risks

computers are becoming indespensable

For these reasons, more and more jurisdictions are turning to automated information management systems to better handle the unique demands associated with hazardous materials. Applications range from the simple automation of lists to expert systems that can apply problem-solving skills to social and physical phenomena associated with emergency planning and response.

OTHER ANALYTICAL TECHNIQUES

In addition to the methods already described, other more sophisticated techniques are available for evaluating hazards, These procedures, which require techical personnel and empirical data or good models, may be appropriate for the analysis of particular types of hazards. They include:

advanced techniques used in evaluating chemical hazards

* Hazard and operability study (HAZOP)
* Event tree analysis
* Fault tree analysis
* Failure modes, effects, and criticality analysis (FMECA)

These methods for risk analysis are highly complex, and the methodologies employed are under continual development by experts in the field. It is therfore suggested that planners intending to use them seek appropriate support. More information is available in Technical Guidance for Hazards Analysis and other sources.

Appendix A

BIBLIOGRAPHY

A. Federal Emergency Management Agency, Environmental Protection Agency, Department of Transportation, Risk Assessment /Vulnerability Users Manual for Small Communities and Rural Areas, March 1986.

B. Federal Emergency Management Agency, Hazardous Materials Contingency Planning Course, November 1989.

C. Environmental Protection Agency, Federal Emergency Management Agency, Department of Transportation, Technical Guidance for Hazards Analysis, December 1987.

D. Environmental Protection Agency, Federal Emergency Management Agency, Department of Transportation, Handbook of Chemical Hazard Analysis Procedures, and associated computer software known as the Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE), 1989.

E. National Response Team, Hazardous Materials Emereency Planning Guide (NRT-1).

F. Department of Transportation, Emergency Resoonse Guidebook, 1987.

G. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

H. Resource Conservation and Recovery Act (RCRA), including the Hazardous and Solid Waste Amendments of 1984 (HSWA).

RELATED PROGRAMS

Environmental Protection Agency's Chemical Emergency Preparedness Program (CEPP)

Chemical Manufacturers Association's Cornmunitv Awareness and Emergency Response Program (CMA/CAER)

Appendix B

GLOSSARY

Act	Superfund Amendments and Reauthorization Act of 1986 (see SARA).
Annex (functional)	Parts of the EOP that begin to provide specific information and direction; should focus on operations, what the function is and who is responsible for carrying it out, emphasize responsibilities, tasks, procedures, and operational actions that pertain to the function being covered, including activities to be performed by anyone with a responsibility under the function. Should clearly define and describe the policies, procedures, roles, and responsibilities inherent in the various functions before, during, and after any emergency period.
Appendix (of Annex)	Hazard-specific: addresses each hazard that threatens the jurisdiction. Unique characteristics of various hazards will not be adequately covered in the functional annexes; to properly treat such unique factors is the purpose or role of the hazard-specific appendixes to the functional annexes.
CAER	Community Awareness and Emergency Response: program adopted by member companies of the Chemical Manufacturers Association (CMA), designed to integrate facility emergency response plans with community emergency response plans and provide the public with information on chemicals manufactured or used at local chemical plants. Anticipated many eventual requirements of CEPP and SARA.
CAMEO	Computer-Aided Management of Emergency Operations: computer data-base storage-retrieval of pre-planning data for on-scene response use in hazmat incidents. Includes systematic MSDS data on common chemicals, air-plume modeling program and pre-planning displays of chemical storage sites and amounts of designated sites, based on prior input of data received from facility managers. “Codebreaker” feature can identify wide range of substances via instant cross-reference procedure. Developed by and available via USCG and NOAA.
CEPP	Chemical Emergency Preparedness Program developed by the Environmental Protection Agency to address accidental releases of acutely toxic chemicals. Many parts adopted by Congress into SARA.

CERCLA	The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund), regarding hazardous substance releases into the environment and the cleanup of inactive hazardous waste disposal sites; establishes authority to tax chemical and petroleum industries to finance a $1.6 billion response trust fund (the Superfund or Fund), and provides broad Federal authority to respond directly to releases or threatened releases of hazardous substances and pollutants or contaminants that may endanger public health or welfare or the environment. EPA is primarily responsible for implementing Superfund. Under CERCLA, EPA may take legal action to force those responsible for hazardous substance releases to clean them up or to reimburse EPA for costs or cleanup. Reauthorized via SARA. (Codified as: 42 USC 9601 et. seq.)
CHEMTREC	CHEMical TRansportation Emergency Center, operated by the Chemical Manufacturers Association to provide information and/or assistance to emergency responders. CHEMTREC contacts the shipper or producer of the material for more detailed information on the chemical released, to facilitate response and cleanup actions. CHEMTREC maintains technical information files on over 300,000 proprietary chemicals. During emergencies, CHEMTREC can provide information regarding the effects of most chemicals on persons or the environment and suggest methods for treatment, containment and control of an incident. CHEMTREC also maintains a directory of experts and industry assistance teams that can assist in emergency. CHEMTREC can be reached 24 hours a day (800-424-9300). REMEMBER: A call to CHEMTREC does not fulfill any statutory or regulatory reporting requirement of the Federal government.
Community Emergency Coordinator	A person appointed for the local emergency planning committee (pursuant to SARA), who makes determinations necessary to implement plans, and who receives official emergency notification of releases.
Comprehensive Emergency Management (CEM)	An integrated approach to the management of emergency programs and activities for all four emergency phases (mitigation, preparedness, response, and recovery), for all types of emergencies and disasters (natural, manmade, and attack), and for all levels of government (local, State, and Federal) and the private sector.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980	Legislation (PL 96-510) covering hazardous substance releases into the environment and the cleanup of inactive hazardous waste disposal sites. CERCLA established the "Superfund" to provide resources for these cleanups. Amended and extended by SARA. (See CERCLA)

Contingency Plan	A document to identify and catalog the elements required to respond to an emergency, to define responsibilities and specific tasks, and to serve as a response guide.
CPG l-8	Guide for Development of State and Local Emergency Operations Plans, prepared by FEMA (see EOP).
CPG 1-8a	Guide for the Review of State and Local Emergency Operations Plans, prepared by FEMA. Provides FEMA staff with a standard instrument for assessing EOPs that are developed to satisfy the eligibility requirement to receive Emergency Management Assistance (EMA) funding. Also called the "crosswalk' checklist. Utilized in development of NRT-la.
CPG 1-35	Hazard Identification. Capability Assessment, and Multi-Year Development Pian for Local Governments, prepared by FEMA. A planning tool to guide local jurisdictions through a logical sequence for identifying hazards, assessing capabilities, setting priorities, and scheduling activities to improve capability over time.
Critical Facilities	Facilities essential to emergency response, such as fire stations, police stations, hospitals and communication centers.
DOT	Department of Transportation.
Emergency Management Institute (EMI)	Component of FEMA's National Emergency Training Center located in Emmitsburg, Maryland. It conducts resident and non-resident training activities for Federal, State, and local government officials, managers in the private economic sector, and members of professional and volunteer organizations on subjects that range from civil nuclear preparedness systems to domestic emergencies caused by natural and technological hazards.
EOP	Emergency Operations Plan, an all-hazards document, which specifies actions to be taken in the event of natural disasters, technological accidents, or nuclear attack; identifies authorities, relationships, and the actions to be taken by whom, what, when, and where based on predetermined assumptions, objectives, and existing capabilities. May include a HazMat appendix in each functional annex (which suffices for Title III compliance).
Emergency Planning Notification	Notice a facility must make to the Commission, declaring itself to be subject to the emergency planning requirements of Title III. [sec. 302(c) of SARA]

ERG	Emergency Response Guidebook, published and distributed by DOT for response personnel's initial use on-scene at HazMat events. Latest issue is dated "1987." Earlier editions should be discarded.
Emergency Response Plan	Comprehensive emergency response plan developed by the the Committee (local), in compliance with Title III (sec. 303), for submission to SERC; outlines procedures for chemical emergency planning and response.
EPA	U.S. Environmental Protection Agency, primary CERCLA agency; chair of NRT. Title III Hotline (800) 5350202; in Washington, D.C. (202) 479-2449, 8:30 a.m. - 4:30 p.m. Monday - Friday. (Also known as CEPP Hotline.)
Exercise	Maneuver or simulated emergency condition involving planning, preparation, and execution; carried out for the purpose of testing, evaluating, planning, developing, training, and/or demonstrating emergency management systems and individual components and capabilities, to identify areas of strength and weakness for improvement of emergency plan (EOP).
Extremely Hazardous Substance	EPA list of 300-plus substances named in Appendix D of 40 CFR Part 300, as described in SARA section 302(a)(2). Section 302, 303 and 304 of CERCLA apply to these substances. Length of list may be altered by EPA review process.
Facility	As defined by section 101 of CERCLA, means any building, structure, installation, equipment pipe or pipeline (including any pipe into a sewer or publicly-owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, or aircraft, or any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located; but does not include any consumer product in consumer use or any vessel. For the purpose of the emergency release notification, the term includes motor vehicles, rolling stock, and aircraft.
Facility Emergency Coordinator	Facility representative for each facility with an extremely hazardous substance (EHS) in a quantity exceeding its threshold planning quantity (TPQ), who participates in the emergency plating process.
FEMA	Federal Emergency Management Agency, responsible for administering training funds under Title III of SARA. Broader responsibilities include assistance in all aspects of community planning, preparedness and response to the full range of likely disasters and emergencies, including recommendation for a Presidentially-declared disaster area

	and administration of disaster funds. Provides a range of expertise and administrative skills in community preparedness planning via state emergency offices.
Hazard	Any situation that has the potential for causing damage to life, property, and/or the environment.
Hazard Identification	The Hazard Identification is part FEMA's CPG l-35, of the "Hazard Identification, Capability Assessment, and Multi-Year Development Plan" (HICA/MYDP, op. cit.) information system, which is completed (and updated annually) by State and local emergency management organizations. The Hazard Identification provides a structured approach for identifying those hazards judged by local officials to pose a significant threat to their jurisdiction.
HazMat	Hazardous Materials: any substance or material in a particular form or quantity which the Secretary of Transportation finds may pose an unreasonable risk to health, safety, and property, or any substance or material in a quantity or form which may be harmful to humans, animals, crops, water systems, or other elements of the environment if accidentally released. Substances so designated may include explosive, radioactive materials, etiologic agents, flammable liquids or solids, combustible liquids or solids, poisons, oxidizing or corrosive materials, and flammable gases. Defined via rulemaking process, under authority of PL 93-633.
Hazards Analysis	The procedure for identifying potential sources of a hazardous materials release, determining the vulnerability of an area to a hazardous materials release, and comparing hazards to determine risks to a community.
Hazards Identification	Provides information on which facilities have extremely hazardous substances (EHSs), what those chemicals are, and how much there is at each facility. Also provides information on how the chemicals are stored and whether they are used at high temperatures. Mandatory facility reporting under Title III will provide most of the information needed for a hazards identification.
HMCP	HazMat Contingency Planning Course designed by FEMA, EPA, and DOT, for SERC and LEPC briefing. Delivered at local level by "Qualified Instructor" cadre trained at EM1 campus of FEMA.
HMIX	Hazardous Materials Information Exchange: a national data repository and "bulletin board" for all states' use regarding planning, training courses, regional activities, and recent legislation or regulatory updates. It is available to any communications-capable personal computer by dialing directly to (312) 972-3275; or FTS 972-3275.

Integrated Emergency Management System (IEMS)	Strategy for implementing emergency management activities which builds upon those functions which are common to preparedness for any type of occurrence; and which provides for special requirements of individual emergency situations. Seeks function-based plan annexes which can be adapted to varied hazard events.
LEPC	Local Emergency Planning Committee. A committee appointed by the State emergency response commission (SERC), as required by Title III of SARA, to formulate a comprehensive emergency plan for its district. (See "Committee.")
LOC	Level of Concern. The concentration of an extremely hazardous substance (EHS) in the air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.
Material Safety Data Sheet (MSDS)	Compilation of the health, flammability, and reactivity hazards of a chemical. It is a legal document, required by the OSHA 1910.1200(g) Hazard Communication Standard (Title 29 CFR). Required by SARA to be submitted to LEPC, SERC and local fire department by chemical manufacturer or importer. Each MSDS contains information about safe handling of a hazardous chemical in the workplace, and will contain recommended exposure limits, by such organizations as the American Conference of Governmental Industrial Hygienists (ACGIH).
National Contingency Plan (NCP)	Term referring to the National Oil and Hazardous Substances Pollution Contingency Plan. Regulations prepared by the Environmental Protection Agency implement the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the response systems of the Clean Water Act (sec. 311); refer to 40 CFR Part 300. It establishes three organizational levels: the National Response Team (NRT), Regional Response Teams (RRTs) and On-Scene Coordinators (OSCs), and can be implemented using two sources of federal response funding. One fund enables the OSC to conduct oil spill activities, the other is used for chemical releases. The NRT's membership consists of 14 federal agencies with interests and expertise in various aspects of emergency response to pollution incidents. The Environmental Protection Agency (EPA) serves as chairman and the Coast Guard serves as vice-chairman of the NRT. The NRT is primarily a national planning, policy and coordinating body and does not respond directly to incidents. The NRT provides policy guidance prior to an incident and assistance as requested by an OSC via an RRT during an incident. NRT assistance usually takes the form of technical advice, access to additional resources/equipment or coordination with other RRTs. (See RRT and OSC, op. cit.)

National Fire Academy (NFA)	A component of FEMA's National Emergency Training Center located in Emmitsburg, Maryland; provides fire prevention and control training for the fire services and allied services. Courses are offered in technical, management, and prevention subject areas. A growing off-campus course delivery system is operated in conjunction with State fire training program offices.
National Response Center (NRC)	A communications center for activities related to response actions; it is located at Coast Guard Headquarters in Washington, D.C. Established under the Clean Water Act and CERCLA, and operated by the U.S. Coast Guard. The NRC receives and relays notices of discharges or releases, disseminates reports when appropriate, and provides facilities for use in coordinating a national response action when required. For release reporting call 24 hours a day (800) 424-8802; in Washington, D.C. call (202) 426-2675.
National Response Team (NRT)	Organization of representatives from 14 federal agencies with responsibility for national planning and coordination (interagency and inter-jurisdictional) of CERCLA objectives.
NETC	FEMA's campus in Emmitsburg, Maryland, known as the National Emergency Training Center (NETC); composed of the National Fire Academy (NFA) and the Emergency Management Institute (EMI). NFA deals directly and specifically with firefighting professionals, including hazardous materials training. For the rest of emergency personnel EM1 develops, monitors and delivers training regarding all categories of emergency and disaster threats to communities, including hazmat.
NOAA	National Oceanic and Atmospheric Administration, central agency in development of CAMEO computer system for hazmat response and planning use, especially air-plume and surface-slick dispersion modeling. Functions under the Department of Commerce. Provides Scientific Support Coordinators (SSCs) in coastal and marine areas. SSCs serve as members of the OSC's staff, as scientific and technical advisors. Their capabilities include contingency planning, surface/subsurface trajectory forecasting, resource risk analysis, technical hazard data assessment and general communications. The SSC serves as principal point-of-contact for members of the scientific community.
NRT-1	Emergency Planning Guide issued by NRT, dated March 1987; fulfills Congressional requirement for unified Federal guidance document for HazMat emergency planning. Product of numerous inputs from State and local government, industry, emergency planners, environmental groups, and the public. Known to some as the "orange book," and is a key, central document for LEPC/SERC guidance.

NRT- 1A	"Criteria for Review of Hazardous Materials Emergency Plans", issued by NRT in May 1988, to assist communities in assessing the effectiveness of their plans. Derived in part from FEMA documents such as CPG 1-8, 1-8a and NRT-1.
OSHA	Occupational Safety and Health Administration, responsible for workplace safety regulation, including HazMat responders training standards.
RCRA	Resource Conservation and Recovery Act (of 1976): established a framework for proper management and disposal of all wastes; directed EPA to identify hazardous wastes, both generically and by listing specific wastes and industrial process waste streams. Generators and transporters are required to use good management practices and to track the movement of wastes with a manifest system. Owners and operators of treatment, storage, and disposal facilities also must comply with standards.
Regional Response Team	Established under CERCLA and operated under the National Response Team, chaired by EPA and co-chaired by Coast Guard; composed of representatives of Federal agencies and a representative from each State in the Federal region. During a response to a major hazardous materials incident, the OSC may request that the RRT be convened to provide advice or recommendations. May be convened by the chairman when a hazardous materials discharge or release exceeds the response capability available to the OSC in the place where it occurs; crosses regional boundaries; or may pose a substantial threat to the public health, welfare, or environment, or to regionally significant amounts of property. RRTs may review plans developed in compliance with Title III, if the local emergency planning committee so requests. RRTs receive direction from the National Response Team; RRT membership parallels National Response Team membership. Responds to emergency situations at the direction of EPA/USCG on-scene coordinators.
Release	Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles) of any Hazardous Chemical, Extremely Hazardous Substance, or CERCLA Hazardous Substance which enters the environment.
Risk	A measure of the probability that damage to life, property, and/or the environment will occur if a hazard manifests itself; this measure includes the severity of anticipated consequences to people.

Risk Analysis	Assesses probability of damage (or injury) due to hazardous materials release and actual damage (or injury) that might occur, in light of the hazard analysis and vulnerability analysis. Some planners may choose to analyze worst-case scenarios. Use the Chemical Profiles in the CEPP technical guidance or a similar guide to obtain information.
Risk Area	An area considered likely to be affected by a release of a toxic chemical. Risk areas are based on recommended isolation distances (i.e., one-half mile radius in all direction and one mile downwind), identifiable land features (streets, addresses, rivers, etc.) and predominate wind directions.
Risk Assessment	Broadly defined as the scientific activity of evaluating the toxic properties of a chemical and the conditions of human exposure to it, with the objective of determining the probability that exposed humans will be adversely affected.
SARA	Superfund Amendments and Reauthorization Act of 1986 (PL99-499). Extends and revises Superfund authority (in Title I & II). Title III of SARA includes detailed provisions for community planning and Right-To-Know systems.
SERC	State Emergency Response Commission, designated by the Governor, responsible for establishing hazmat planning districts and appointing/overseeing Local Emergency Planning Committees.
State Emergency Operations Plan	Plan designated specifically for State-level response to emergencies or major disasters; which sets forth actions to be taken by the State and local governments, including those for implementing Federal disaster assistance. (See EOP, op. cit.)
Superfund	Trust fund established under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and extended under the 1986 Superfund Amendments and Reauthorization Act (SARA) to provide money for cleanups associated with inactive hazardous waste disposal sites. (See CERCLA)
Superfund Ammendmen t s and Reauthorization Act of 1986 (SARA)	Act (PL99-499) reauthorizing the Comprehensive Environmental Response, Compensation, and Liability Act for another 5 years. Under Title III of SARA, new authorities are established for chemical emergency planning and preparedness, community right-to-know reporting, and toxic chemical release reporting.

Tier I or Tier II	Inventory form for reporting Hazardous Chemicals (Sec. 312) and Extremely Hazardous Substances (Sec. 302). Tier II describes more detailed chemical quantity and location(s) within the facility.
Title III (or SARA)	The "Emergency Planning and Community Right-to Know Act of 1986." Specifies requirements for organizing the planning process at the State and local levels for specified extremely hazardous substances; minimum plan content; requirements for fixed facility owners and operators to inform officials about extremely hazardous substances present at the facilities; and mechanisms for making information about extremely hazardous substances available to citizens. (42 USC annot., sec. 11001, et. seq.-1986)
Toxic Chemical	A substance so listed in the latest version of the Federal Register; determined to be of potential danger to human health/life by EPA in conjunction with HHS. (ref. sec. 313-c).
Toxic Materials	Substances that can be poisonous if inhaled, swallowed, or absorbed into the body through cuts or breaks in the skin.
Toxicity	The ability of a substance to cause damage to living tissue, impairment of the central nervous system, severe illness, or death when ingested, inhaled, or absorbed by the skin.
Vulnerability Analysis	Identifies what is susceptible to damage. Should provide information on: extent of the vulnerable zone; population, in terms of size and types that could be expected to be within the vulnerable zone; private and public property that may be damaged, including essential support systems and transportation corridors; and environment that may be affected, and impact on sensitive natural areas and endangered species. Refer to the CEPP technical guidance or DOT's Emergency Response Guidebook to obtain information on the vulnerable zone for a hazardous materials release. A standard vulnerability analysis has been developed by EPA to assist communities in addressing sec. 303 of Title III.
Workers Right-to-Know	Legislation mandating communicating of chemical information to employees. A regulatory initiative by OSHA, and an antecedent to Community Right to Know.

* * * * *

This Glossary of Terms was developed at the Emergency Management Institute in Emmitsburg, MD, in response to a need by students in the Hazardous Materials Contingency Planning Course. It has been reviewed by numerous federal agencies involved in implementing Title III of the Superfund Amendments and Reauthorization Act of 1986, known as SARA. The Glossary may be reproduced without copyright limitations, provided it is reproduced in its entirety and no proprietary product is developed directly from its pages.

It may be used for any Title III application, by public agencies and private organizations engaged in training or public awareness regarding the new Title III provisions for local emergency planning committee or state emergency response commissions.

Any comments for additions or revisions should be directed to the Technical Programs Division of the Emergency Management Institute, Emmitsburg, MD 21727; or directly by phone to (301) 447-1282 (FTS 652-1282).

Additional materials relating to SARA's Title III are available through numerous federal agencies, including the Environmental Protection Agency (EPA), which is the primary agency in Super-fund, plus the Department of Transportation (DOT), and also the Federal Emergency Management Agency (FEMA), which includes the Emergency Management Institute campus as its main training outlet. If you have questions regarding available training from these or other agencies, contact your local or state emergency management or disaster planning agency.

☆US GOVERNMENT PRINTING OFFICE: 1993—720-649/ 80170