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EPA

Review of Emergency Systems

Final Report

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Report to Congress

Section 305(b) Title III Superfund Amendments and Reauthorization Act of 1986

EXECUTIVE SUMMARY

In 1984, an accidental release of methyl isocyanate from a chemical plant in Bhopal, India, created a cloud of toxic vapors that left over 2,000 people in the surrounding community dead and several thousand more injured. This tragedy created worldwide concern about the potential for similar accidents elsewhere. In the United States, the concern intensified when, not long afterward, a large release of aldicarb oxime occurred at a facility in Institute, West Virginia, fortunately without loss of life.

These incidents clearly demonstrated the potential for disastrous accidental releases of the chemicals that have become part of modern life. The result was a new urgency in efforts to establish national programs to address chemical accidents. Under the Air Toxics Strategy, the Administrator of the U.S. Environmental Protection Agency (EPA) committed the Agency to the prompt development of a program to foster community planning and preparation for serious releases. The result, EPA's Chemical Emergency Preparedness Program (CEPP), was launched nationally in November 1985 as a voluntary effort. In 1986, Congress mandated many facets of CEPP in the Emergency Planning and Community Right-to-Know Act, Title III of the Superfund Amendments and Reauthorization Act (SARA).

Title III creates a structure for emergency planning efforts. The legislation's requirements ensure that State and local governments will have entities in place to receive information from industry and to coordinate planning with industry. These entities, the State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs), bring together representatives of all the important elements, including environmentalists, health organizations, and public officials. The SERCs and LEPCs provide a forum for a continuing dialogue on accident prevention and community preparedness.

Section 305(b) of Title III required EPA to conduct a "review of emergency systems for monitoring, detecting, and preventing releases of extremely hazardous substances at representative domestic facilities that produce, use, or store" these substances and to report to Congress on the findings from the review and the Agency's recommendations for initiatives to develop or improve emergency systems. EPA submitted an interim report in May 1987. This final report to Congress fulfills the requirements of Section 305(b).

APPROACH

EPA developed its approach to the review in consultation with the States, with professional and trade associations, and with environmental groups. An EPA workgroup, with the participation of the Federal Emergency Management Agency (FEMA), collected information for the review from four sources:

- Literature on previous and ongoing research.

- Literature on previous and ongoing research.
- A questionnaire to obtain qualitative information from a wide range of domestic facilities.
- Another questionnaire on public alert systems sent to communities with jurisdiction over the surveyed facilities.
- Site visits to a limited number of the surveyed facilities.

The review focused on 21 chemicals chosen from the SARA Section 302(a) list of extremely hazardous substances. These 21 chemicals were selected to provide a sample of chemicals representative of the list as a whole. Only facilities that handled one or more of the 21 chemicals in certain quantities received questionnaires.

After evaluating the information obtained from these sources, EPA convened panels of technical experts to review preliminary findings and provide additional information. The Agency then presented its findings and recommendations to the States for comment. An early version of this report was given a limited review by outside parties, including States, industry, trade associations, other Federal agencies, environmentalists, and the expert panel chairmen.

FINDINGS

In general, EPA's findings are as follows:

Prevention of accidental releases requires a holistic approach that integrates technologies, procedures, and management practices.

Prevention of chemical accidents requires a comprehensive, integrated approach that takes into account the hazards of the chemicals involved, the hazards of the process, the capabilities of the facility personnel, and the potential impact on the community. Sustaining a comprehensive approach depends on management's commitment to install, maintain, and update appropriate technologies, as well as to provide training for the operators. Active company involvement with the local community and with industry and professional groups also reflects management's commitment to safety.

"State of the art" for technologies and techniques to monitor, detect, and prevent accidental releases cannot be defined generically.

The review indicates that no single technology is most effective in every situation. Site-, process-, and chemical-specific factors dictate the choice of technology or technique as do the operating procedures and management practices employed at a facility. For public alert systems, the effectiveness of a technology depends on the size and characteristics of the population and on the management practices. There is, therefore, no "best" method.

The larger chemical producers appear more aware of potential hazards and of methods to prevent releases.

In general, the larger chemical producers appear to have a better awareness of hazards, and use more methods to address them than do smaller producers and chemical storage facilities, distributors, and repackagers. The larger companies are also more actively involved in industry and professional groups and in community programs. This finding indicates the need to enhance the use of existing mechanisms, such as trade associations, professional groups, and the SERCs and LEPCs, to disseminate to smaller companies information on available technologies and techniques.

Some technologies and techniques need further research and development before they will be technically feasible and cost-effective.

The review identified a number of technologies that require research and development, as well as additional data needs: (1) Inexpensive, reliable, chemical-specific detectors for combustible gases, solids, and corrosives; (2) Laser-based, remote sensing systems; (3) Mitigation technologies for liquid, liquid/vapor, and solid releases; and (4) Data on source characterization, human health effects, equipment failure rates, and human error rates.

The review indicated that few facilities have installed perimeter alert systems. Those facilities that have investigated such systems reported that more reliable and inexpensive perimeter monitors need to be developed for the systems to be technically feasible and cost-effective.

Improved communications are needed in most phases of the public alert systems.

The review indicated that substantial improvements in public alert could be obtained for little cost by establishing effective decision-making and communications procedures between facilities and communities, and between officials and the community. The LEPCs established under Title III should contribute greatly to this end.

RECOMMENDATIONS

Industry, Federal, State, and local authorities all have roles to play in preventing the release of hazardous substances. Because chemical facilities are complex and require site-specific safety assessment and contingency planning, there should be close collaboration between industry and the community. Title III mechanisms such as the LEPCs should enhance prevention by increasing public awareness, public participation, and public expectations for safe operations. The LEPCs should also play an important role in improving local emergency response capabilities. The States, through Title III's SERCs and State agencies, have an active role in overseeing facilities.

Industry must assume the primary responsibility for preventing accidents and ensuring the safety of its workers and the public health of the surrounding community. Industry, with the assistance of professional and trade associations, should also take the lead in conducting research on prevention technologies and in disseminating information. The Federal government should act as a catalyst, identifying problem areas and providing technical assistance when needed.

Specifically, EPA recommends:

- Continuing the expert panels convened to review this study and expanding them to include professional and environmental groups. These panels will provide advice to EPA in a number of technical areas.

- Strengthening the LEPCs and SERCs by providing technical assistance and guidance.

- Conducting further studies on the causes of chemical accidents and ways to prevent them.

- Encouraging industry and professional and trade associations to conduct research that will develop and refine cost-effective, reliable prevention, detection, monitoring, and public alert methods, procedures, and devices. Appropriate means for transferring the results of the research should also be developed.

- Developing guidance, where needed, on such topics as the use of in-place sheltering, hazard assessment techniques, successful management techniques, and prevention methods.

- Working with other agencies to develop training to enhance Federal and State staff expertise in conducting chemical process safety audits.

- Working with international organizations to draw upon their expertise.

- Encouraging the study of management techniques that can be applied to the management of risk and disseminating the results to the industry, especially to smaller facilities.

- Encouraging the development of standard procedures and protocols for public alert decision-making and information collection to expedite the notification of the public in a chemical emergency.

Besides the general recommendations that apply across the several areas considered in this review, EPA also recommends the following:

- In management:

  Management should be trained in hazard evaluation and accident prevention.

- In prevention:

  Emphasis should be placed on pre-release prevention rather than on post-release measures.

  The terminology used in hazard evaluation should be standardized.

  Mitigation technologies for large-scale releases should be evaluated.

- In monitoring and detection:

  The emphasis should be on developing systems that are relatively inexpensive and that do not require frequent calibration or trained technicians to operate.

  The application and interpretation of air dispersion models in real-time situations should be done with great caution, and then only by people aware of the model's limitations and assumptions.

  Remote sensing systems, such as chemical-specific laser systems, should be developed for more general use.

- In public alert:

  Warning message protocols for English and non-English speaking populations should be developed at the local level.

  Notification and alert equipment must be maintained and tested regularly.

  Public warning technologies in high-risk and densely populated areas should be improved.

  Studies of public response to warnings in chemical emergencies should be conducted to improve warning systems.

Each of these recommendations is elaborated in the following chapters.

CONTENTS

Appendices

1. INTRODUCTION

This report presents the findings and recommendations of the U.S. Environmental Protection Agency's (EPA) review of emergency systems for monitoring, detecting, and preventing accidental releases of extremely hazardous substances to the environment, and of systems for alerting the public to such releases. EPA is submitting this report to Congress in fulfillment of Section 305(b) of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA).

1.1 SARA TITLE III: BACKGROUND

In 1986, Congress passed Title III of SARA, called the "Emergency Planning and Community Right-to-Know Act." This legislation requires industry to share information on hazardous chemicals and releases and requires States and local communities to prepare to deal with releases. One of the driving forces behind Title III was a heightened awareness of the potential for chemical releases, caused by a succession of major accidents at chemical facilities. The 1984 accidental release of methyl isocyanate from a chemical plant in Bhopal, India, created a cloud of toxic vapors that left over 2,000 people in the surrounding community dead. This tragedy created worldwide concern about the potential for similar accidents elsewhere. In the United States, the concern was intensified when, not long afterwards, a large release of aldicarb oxime occurred at a chemical facility in Institute, West Virginia. Although no lives were lost at Institute, the facility had no way of automatically notifying the community of the release and the notification given was not timely. These incidents clearly demonstrated the potential for disastrous accidental releases of the chemicals that have become a part of modern life; they also made the public aware that releases of chemicals from the facilities where they are manufactured, processed, used, or stored not only can occur, but do occur, even in this country.

The result was a new urgency in efforts to establish national programs to address chemical emergencies. Under the Air Toxics Strategy, the Administrator of EPA committed the Agency to the prompt development of a program to foster community planning and preparation for serious releases of extremely hazardous substances from local chemical facilities. The result, EPA's Chemical Emergency Preparedness Program (CEPP), was launched nationally in November 1985 as a voluntary program. Congress incorporated many of the facets of the CEPP in Title III. The requirements of Title III ensure that State and local governments will have mechanisms in place to receive information from and to coordinate emergency planning with industry.

1.2 THE STATUTORY REQUIREMENT FOR A REVIEW OF EMERGENCY SYSTEMS

Section 305(b) of SARA includes the requirement that EPA conduct a "review of emergency systems for monitoring, detecting, and preventing releases of extremely hazardous substances at representative domestic facilities that produce, use, or store extremely hazardous substances." EPA was required to report its interim findings in May 1987 and to include recommendations in a final report. EPA submitted its Interim Report in May 1987; this document is the final report required by Section 305(b).

Section 305(b) specifies that the report based on the review shall include findings not only on the status of current technological capabilities to monitor, detect, and prevent releases, but also on the status of devices, systems, and procedures for providing timely and effective public warning of an accidental release. In addition, the report must address the technical and economic feasibility of perimeter monitoring systems for detecting releases from facilities. Recommendations are required on (1) improving devices, systems, and procedures for alerting the public in the event of an accidental release, and (2) initiatives to support the development of new or improved technologies or systems to facilitate the monitoring, detection, and prevention of releases.

The requirement for this review suggests that the public will be alerted more promptly and effectively when a release occurs if adequate public alert devices, systems, and procedures are in place. It also acknowledges that the prevention, monitoring, and detection of accidental releases must rely not only on the technologies in place at facilities that produce, use, or store extremely hazardous substances, but also on management support and effective management practices. By providing information about current technological capabilities at domestic facilities for preventing releases and alerting the public, this review serves as an important adjunct to the emergency planning and community right-to-know provisions of Title III.

1.3 ORGANIZATION OF THIS REPORT

Following this introductory chapter, this report contains six chapters.

- Chapter 2: Approach is a discussion of EPA's approach to conducting the Section 305(b) review. It describes the scope of the review and discusses the methods EPA used to select chemicals and facilities on which to focus the study.

- Chapter 3: General Findings and Recommendations discusses the general findings of this review and provides an overview of the principal recommendations. Recommendations on specific issues are presented in subsequent chapters.

- Chapter 4: Management discusses the importance of management in preventing of releases and outlines the components of a management system. The management practices discussed support the specific technologies and procedures covered in the remaining chapters.

- Chapter 5: Prevention Systems provides a discussion of hazard evaluation, prevention/protection technologies, and post-release mitigation.

- Chapter 6: Monitoring and Detection Systems discusses the findings on the technologies available to monitor and detect releases within the facility and at its perimeter as well as models to predict dispersion of released substances in the air.

- Chapter 7: Public Alert Systems reviews technologies and procedures in use to alert the public to emergencies.

These chapters present the technologies, techniques, and practices related to monitoring, detection, and prevention of accidental releases of extremely hazardous substances, and to alerting the public should a release occur. More detailed technical information is included in the appendices to this report, which begin with a glossary in which the technical terms and acronyms used in this report are defined. Additional technical background materials are available in the EPA reference library.

2. APPROACH

This chapter explains EPA's approach to the Section 305(b) review of emergency systems. It begins with a discussion of the scope of the review, then describes the methods used to collect and analyze the data. The Interim Report to Congress under Section 305(b) provides greater detail on certain aspects of the approach.

2.1 SCOPE

EPA and the Federal Emergency Management Agency (FEMA), which took the lead responsibility for the review of public alert systems, defined the scope of the review in a manner intended to support sound recommendations on the areas specified by Congress in Section 305(b).

Section 305(b) required EPA to review systems for monitoring, detecting, and preventing releases of extremely hazardous substances. "Extremely hazardous substances" are the specific chemicals on the list referred to in SARA Section 302(a), which was published in the Federal Register on November 17, 1986 (51 FR 41570), and revised on April 22, 1987 (52 FR 13378) and on February 25, 1988 (53 FR 5574).

In this report, the phrase "detection system" refers primarily to technologies for detecting leaks or catastrophic releases within process and storage areas. Basically the same technologies are used for detecting releases at the facility fenceline or perimeter. The phrase "monitoring system" refers to methodologies and instrumentation used to perform sampling and analyses in a community potentially affected by a release to determine whether, and to what extent, the released chemical is present in the environment.

The phrase "prevention systems" refers broadly to any technology or management practice that aids in preventing releases of extremely hazardous substances. Prevention systems include not only technologies and procedures that prevent the loss of a chemical from containment in the system in which it is manufactured, processed, used, or stored, but also any technology or procedure that can be used to mitigate a release. Accordingly, the "prevention systems" EPA reviewed include hazard evaluation techniques, monitoring, control, and back-up systems in chemical processes, and techniques for minimizing the dispersion or spread of a release beyond the release point.

The statute also required a review of the status of public alert devices or systems, which include any automatic technology or communications link to warn adjacent communities of a significant release. Because the way in which a public alert technology is used can be at least as important as the technology itself, EPA and FEMA also considered the procedures being used for communications between the facilities and local officials and between those officials and the public.

Section 305(b) stated that EPA "may select representative extremely hazardous substances from the substances on the list referred to in Section 302(a) for the purposes of this review." EPA chose to focus the study on 21 listed chemicals. Section 2.4 of this chapter describes the method EPA used to select the chemicals.

EPA focused this review on sudden, accidental releases -- the types of releases that can be considered emergencies -- rather than on routine emissions. Similarly, the review focused on releases that involve significant quantities of acutely toxic chemicals, rather than chronically toxic chemicals. Chemicals are listed as "extremely hazardous substances" under Section 302(a) because of their acute toxicity, that is, their ability to cause significant adverse effects on human health with brief, one-time exposure. The emergency systems on which this review focused are those able to monitor, detect, or prevent releases that could cause effects from short-term exposures, rather than those systems intended primarily for routine or low-level releases that would endanger human health and the environment only over an extended period.

EPA concentrated the review on facilities that produce, use, or store the 21 extremely hazardous substances that were selected. Only facilities believed to be handling one or more of these 21 substances in certain quantities were included in the surveys and site visits.

The review considered the prevention of releases to any environmental medium -- air, land, surface water, ground water -- but emphasized releases to air because they present the greatest potential for immediate and widespread harm to human health and the environment.

One final aspect of the scope defined for this review deserves emphasis. EPA considered management practices and operating procedures to be integral components of the emergency systems and technological capabilities the review was required to assess. The commitment of corporate and facility managers to accident prevention is, in fact, the underpinning of effective accident prevention. The installation of the most advanced technologies is an ineffectual safeguard against accidents unless those technologies are properly operated and maintained in a workplace where safety is explicitly and implicitly valued. Accordingly, this review addressed management practices and procedures.

2.2 METHODOLOGY OF THE REVIEW

EPA's approach to this review involved the following steps:

- A review of previous research, studies, documentation, and ongoing research to identify available technologies, systems, procedures, and methodologies;
- The selection of 21 chemicals on which to focus the review;
- The selection of a sample of domestic facilities believed to be handling the 21 substances at levels above the Section 302(a) threshold planning quantity (TPQ). The purpose was to collect data to determine which of the available technologies are being used;

- A survey of the sample of facilities, using a written questionnaire;
- A parallel survey of the communities surrounding the selected facilities, again using a written questionnaire;
- Site visits and interviews at a limited number of the surveyed facilities to supplement the information from the questionnaires;
- An analysis of the data obtained through the preceding steps to generate findings;
- A review of the findings by a panel of technical experts; and
- Consultations with selected States on the findings and recommendations.

Throughout the study the Agency consulted with States, industry, professional organizations, trade associations, and environmental groups. (The States that participated in the review are California, Delaware, Illinois, Maryland, New Jersey, Ohio, Tennessee, and West Virginia.) A public meeting on the Agency's proposed approach for the study as well as on the interim findings was held on April 14, 1987. The first versions of the questionnaires were circulated to both the States and professional groups for comment. The facility questionnaire was then pretested at a few facilities suggested by the Chlorine Institute before being revised and sent to the full sample of facilities. Once the initial analysis of the data was complete, EPA convened expert panels to review the findings before again meeting with representative States to discuss the findings and proposed recommendations. Drafts of the report were circulated to certain States and key professional groups for their comments, as well as to the chairmen of the expert panels.

2.3 RESEARCH AND LITERATURE REVIEW

EPA conducted a literature search to identify available technologies and techniques. Included were reports on ongoing prevention projects, industry research, symposia, and past studies on the full range of emergency systems.

To conduct the literature search, a number of engineering data bases were searched to provide coverage of the world's significant engineering and technological literature. Journals, publications of engineering societies and organizations, technical reports, monographs, and publications from conferences were searched for relevant citations. Books as well as manufacturers' literature on specific technologies were also reviewed. The literature search provided a basis for defining what technologies are available and for identifying areas of ongoing research. A bibliography of the literature reviewed is included as Appendix 14 to this report.

2.4 SELECTION OF CHEMICALS

Congress stated that EPA could select "representative" chemicals from the Section 302(a) list of extremely hazardous substances for the purpose of this review. As noted, EPA selected 21 chemicals. These chemicals are listed in Exhibit 2-1. The selection process, which was described in detail in the Interim Report, was designed to yield a sample of chemicals representative of a broad range of hazards common to the chemical industry. Accordingly, the monitoring, detection, prevention, and public alert systems used by the facilities handling these chemicals should be representative of the emergency systems used by many facilities that handle extremely hazardous substances.

EPA chose nine chemicals because of their large production volumes, widely acknowledged potential hazards, involvement in past plant and transportation accidents, and generally recognized special handling procedures and controls. These chemicals -- ammonia, chlorine, hydrocyanic acid, hydrogen fluoride, hydrogen sulfide, methyl isocyanate, phosgene, sulfur dioxide, and sulfur trioxide -- provide a wide range of reactivity, flammability, and corrosivity hazards. The remaining 12 chemicals were selected from the list of extremely hazardous substances, using a random number generation technique within certain guidelines. Specifically, the selection process was designed to yield a mix of physical and chemical characteristics, as indicated in Exhibit 2-1. EPA initially selected 20 chemicals. However, when the Agency could not identify a significant number of facilities that handled the two liquids with medium vapor pressure -- hydrazine and tetraethyltin -- the Agency selected a twenty-first chemical with similar characteristics, benzotrichloride, to increase the number of potential respondents in that category.

2.5 FACILITY SELECTION

In consultation with State agencies, trade and professional associations, and public interest groups, EPA identified data bases listing facilities that were believed to manufacture, process, use, or store the 21 selected chemicals. Published reference sources for the chemical industry were also collected. The facilities identified from these sources served as the frame from which the sample of facilities to survey was selected. Several conditions guided the selection of the facilities to survey:

- An individual facility could be surveyed for only one chemical.

- Up to two facilities of a company handling the same chemical could be surveyed, but only if there were known to be significant differences between the two with respect to age, type of process, or quantity of the chemical handled.

- When one facility had to be selected from several handling a chemical at levels above the TPQ, the decision was based on which facility seemed most important to include for the purposes of the survey. The factors considered included the number of other facilities handling the chemical, the need to include major uses and major production processes for each chemical, and the need to include diversity in the sample with respect to location, age, and size.

EXHIBIT 2-1

SAMPLE OF EXTREMELY HAZARDOUS SUBSTANCES FOR REVIEW

Chemical Name	Form	Vapor Pressure[1]	TPQ (lbs)[2]
Acrylonitrile	Liquid	High	10000
Ammonia*	Gas	High	500
Benzenearsonic acid	Solid	Low	10
Benzotrichloride	Liquid	Medium	100
Chlorine*	Gas	High	100
Chloroacetic acid	Solid	Low	100
Furan	Liquid	High	500
Hydrocyanic acid*	Gas	High	100
Hydrazine	Liquid	Medium	1000
Hydrogen fluoride*	Gas	High	100
Hydrogen sulfide*	Gas	High	500
Mechlorethamine	Liquid	Low	10
Methiocarb	Solid	Low	500
Methyl bromide	Gas	High	1000
Methyl isocyanate*	Liquid	High	500
Phosgene*	Gas	High	10
Sodium Azide	Solid	Low	500
Sulfur dioxide*	Gas	High	500
Sulfur trioxide*	Solid	High	100
Tetraethyltin	Liquid	Medium	100
Trichloroacetyl Chloride	Liquid	Low	500

1. Vapor pressure ranges: High - > 100 mm of mercury
   Medium - $1 \leq vp \leq 100$ mm of mercury
   Low - < 1 mm of mercury

2. Threshold planning quantity (TPQ), the quantity of an extremely hazardous substance present at a facility that will trigger the planning requirements of SARA Section 302. The TPQs listed above for solids apply when the substance is molten, a fine powder, or in solution; otherwise the TPQ for solids is 10,000 lbs.

* Denotes one of the nine chemicals selected because of high production volumes, recognized hazards, involvement in past accidents, and recognized need for special handling procedures.

When fewer than 100 facilities were identified as handling a chemical, all facilities were surveyed unless they were disqualified by the above conditions. More than 100 facilities were identified for only four chemicals: ammonia, chlorine, hydrogen sulfide, and sulfur dioxide. Additional considerations -- use of the chemical, size of the chemical operations, age of the facility, release history, location, and the reliability of the data bases through which the facilities were identified -- were used to select a sample of under 100 facilities for each of these four chemicals.

2.6 FACILITY AND COMMUNITY SURVEYS

In the fall of 1987, EPA mailed questionnaires to 522 facilities selected as described above. The questionnaire, which is included in this report as Appendix 12, requested detailed information on:

- Major unit processes and operations at the facility, including:
  - Potential process and chemical hazards.
  - An engineering drawing of the process highlighting the potential release points.
  - A description of relevant equipment and personnel.
  - An inventory of the quantities of extremely hazardous substances used at the facility.
  - A description of equipment to prevent, detect, and monitor releases.
- The types of procedures used to prevent, detect, and mitigate accidental releases and any potential hazards identified, including techniques available to model the dispersion of released substances, and spill control techniques and technologies.
- Relevant management practices, including reporting practices, hazard evaluation programs, plans for upgrading prevention technologies and procedures, management organization relating to safety and to accident prevention, and operator training programs.
- Public alert equipment and technologies as well as administrative practices, concentrating on notification of the local community and on activities (such as emergency simulation exercises) conducted with the community.

Separate questionnaires developed in conjunction with FEMA were mailed to 277 communities that have jurisdiction over one or more of the selected facilities. Because the Local Emergency Planning Committees (LEPCs) established under Title III were just being formed, the surveys were mailed to the head of the local agency responsible for emergency planning, with the instruction that the questionnaire should be completed by the person in charge of emergency planning with the facility. The community questionnaire, which is included as Appendix 13 of this report, requested information on:

- Community emergency planning organization and staffing, designated contact points between the facility and the community, and primary and back-up communication equipment used by the facility to notify the community.

- Procedures used in an emergency, communication equipment used to notify the public, information needed from the facility, and time needed to make decisions in an emergency situation.

- Specific land use and populations (residential, industrial, commercial, institutional) within one and five miles of the facility.

- Coordination with other emergency response organizations.

Approximately one-third of the facilities producing, handling, or storing the 21 chemicals above the TPQ, and half of the communities returned completed questionnaires. For details on the respondents, see Appendix 2.

2.7 SITE VISITS

To confirm and clarify the survey information, EPA conducted seven site visits to facilities that produce, use, or handle phosgene, chlorine, acrylonitrile, sulfur dioxide, sulfur trioxide, and hydrogen fluoride. Trained representatives from EPA and States verified the information on the questionnaire and discussed management approaches in detail with company staff. The site visits provided an opportunity to obtain in-depth information to augment the data from the survey. The reports from the site visits are summarized in Appendix 9.

2.8 ANALYSIS

After the survey questionnaires were returned, EPA and FEMA evaluation teams analyzed the data from the surveys as well as the information gained from the literature search. The evaluation teams were composed of EPA and FEMA staff. The evaluation teams focused on certain questions: what technologies and procedures are available, which are being used, and why facilities and communities made the choices they have. EPA then convened five panels of experts to review the findings and to provide supplemental information where possible. The five panels covered hazard assessment and prevention, monitoring and detection, mitigation, management, and public alert. The panels included prominent representatives from industry, State and other government agencies, and academia.

2.9 LIMITATIONS OF THE DATA

EPA designed the surveys to provide a broad "snapshot" of current practices and technologies in use. The survey samples were not designed to yield statistically significant results. Consequently, the results are not to be interpreted as statistically significant. The findings from the questionnaires reflect conditions at the facilities and communities that returned questionnaires, not necessarily conditions at all facilities in the original sample or in the domestic industry as a whole.

The holistic nature of prevention and response systems creates difficulties in interpreting the survey findings. A single fact, or a set of facts, such as the presence and use of particular prevention technologies, does not provide sufficient information to judge the degree of prevention provided at a particular facility. Conversely, the absence of certain technologies may not mean that the facility is doing less than it should to prevent releases, because, for any facility, many alternative ways to prevent releases may be available. The absence of certain critical practices, such as preventive maintenance, however, can be taken as an indication of insufficient emphasis on accident prevention.

While the information collected in this review must be interpreted with an awareness of its limitations, EPA believes the data provide insight into current accident prevention practices. In particular, the data indicate areas of possible concern and areas where additional information, research, guidance, and study would be useful.

3. GENERAL FINDINGS AND RECOMMENDATIONS

This chapter discusses the overall findings and recommendations of the review. Findings and recommendations that relate to specific types of emergency response systems are discussed in subsequent chapters.

3.1 FINDINGS

Prevention of accidental releases requires a holistic approach that integrates technologies, procedures, and management practices.

Prevention of accidental releases requires a comprehensive, integrated approach that takes into account the hazards of the chemicals involved, the hazards of the process, the capabilities of the facility personnel, and the potential impact on the community. Prevention should be considered at every stage of development and operation -- siting, layout, design, redesign, retrofit, and shutdown -- and prevention measures should be built into the facility. In general, it is more cost-effective to prevent accidents than to attempt to mitigate releases when they occur. For some releases, especially unconfined vapor releases, mitigation may not be technically feasible.

A comprehensive approach to safety is dependent on management's commitment to the safe operation of the facility. This commitment includes the willingness to install, maintain, constantly review, and update the appropriate technologies where needed. The development of training and refresher training programs as well as maintenance programs is essential to ensure that the facility is operated safely. Management commitment is also reflected in extensive company interactions with the local communities and with industry and professional groups.

"State of the art" for the technologies and techniques used to monitor, detect, and prevent accidental releases cannot be defined generically.

Overall, the Section 305(b) review indicated that there is no single method or technology that works best in every situation. In each area considered in this review, the determination of what constitutes a "state-of-the-art" technology for a particular facility depends on the individual circumstances of the facility -- its location and layout, its process, the chemicals handled, and the hazards associated with the specific chemicals and processes. For example, within process design, the number of possible combinations of equipment is so great that only an overall examination of the design in a particular setting can reveal whether the design is appropriate.

This finding also applies to public alert technologies. While the number of technologies is limited, the appropriateness of any particular system will depend on the characteristics of the community; for example, the notification system needed by a small community at some distance from a facility will be very different from the system needed in urban areas.

Therefore, attempting to specify a "state-of-the-art" technology or technique or management approach for all facilities is neither feasible nor desirable. Each facility must be considered individually, and appropriate technologies must be determined in conjunction with operating procedures and management practices. In addition, labelling a particular technique or technology as "state-of-the-art" may lead facilities to use it, perhaps in inappropriate circumstances, and make no efforts to move beyond it.

The larger chemical producers appear more aware of potential hazards and of methods to prevent releases.

In general, the larger chemical producers appear to have a better awareness of hazards and risk management and implement more release prevention techniques and technologies than do the smaller chemical producers, users, handlers, and distributors. This does not mean that some smaller companies do not have adequate systems for preventing releases, but rather that they appear less aware of the potential for significant releases and the associated prevention methodologies available. It is generally accepted that the smaller companies may not have adequate resources to install the latest prevention technologies; some may consider their inventories insufficient to warrant using the technologies. Many of these companies appear to lack an understanding of formal hazard evaluation techniques. The management commitment of the smaller companies, as demonstrated by participation in industry and community programs, also appears to be lower than that of the larger producers.

Some of the technologies and techniques need further research and development before they will be technically feasible and cost-effective.

The review identified several areas where technologies either do not exist, are unproven for large-scale use, or are still prohibitively expensive for most facilities. For example, it is clear that release detection systems do not exist for some chemicals; of those that do exist, many are not viewed as reliable or cost-effective. Some of the data required for air dispersion modeling and probabilistic risk assessments need to be improved. As explained in subsequent chapters, additional research is needed in these areas.

Congress specifically directed EPA to consider the technical and economic feasibility of perimeter monitoring systems. The review indicated such systems will require additional development before they will be cost-effective and sufficiently reliable to warrant widespread use.

Improved communications are needed in most phases of the public alert process.

The review indicated that substantial improvements in public alert could be obtained for little cost, by establishing effective decision-making and communications procedures between facilities and public officials, and between officials and the community. The planning entities established by Title III, notably the LEPCs, should go far toward solving this problem by fostering dialogue between industry and communities. While sophisticated technologies for warning do exist, unless they are easy to install, maintain, and finance, their use would not necessarily improve the public alert process.

3.2 RECOMMENDATIONS

Industry, Federal, State, and local authorities all have a role to play to prevent accidental releases of hazardous chemicals. Because chemical plants are complex and require site-specific safety assessment and contingency planning, there needs to be a close collaboration between industry and the community with an understanding that the common goal is the prevention of chemical accidents.

Industry should take the primary responsibility for preventing accidents and ensuring the safety of its workers and the public health of the surrounding communities. Local and State governments are responsible for public protection and oversight of the process of preparedness, prevention, and mitigation.

The Federal government should act as a catalyst, identifying problems, and providing guidance and technical assistance to State and local governments and to industry. Assistance to industry should include (1) collecting information on hazardous substances and their effects, (2) informing manufacturers of successful emergency response techniques, and (3) encouraging industry, trade and professional organizations, and States and localities to develop standards and guidelines.

Therefore, all levels of government, industry, professional and trade organizations, and environmental groups must work closely together to:

- Develop and share information on the causes of accidents, on hazard evaluation techniques, and on prevention methods;
- Identify needs and sponsor research to improve the application of hazard evaluation and technologies for monitoring, detecting, and preventing releases of hazardous chemicals;
- Establish a process for exchanging and sharing information nationally and internationally in these areas with the industrial community, with an emphasis on smaller chemical companies, users, and distributors, as well as with the general public; and
- Conduct further studies in specific areas such as the effectiveness of various public warning procedures.

To this end, EPA commits to:

- Continue the dialogue with industry, States, professional and trade organizations, and environmentalists through the expansion and continuation of the technical panels convened for the Section 305(b) study. These panels will deal with issues regarding hazard evaluation and prevention, monitoring and detection, public alert, and management support. They will be asked to refine the discussions in this report, identifying gaps in methods and technologies, and identifying an effective means of disseminating information to those who need it.

- Work to strengthen the State Emergency Response Commissions (SERCs) and LEPCs by providing technical assistance, guidance, and information on chemical hazards, causes of accidents, prevention methods, and effective procedures and technologies for notifying the public of such accidents. This information can be used in their dialogue with industry, not only to aid a community's emergency planning effort and efforts to assess, understand, and manage risk at the local level, but also to stimulate discussion of ways to prevent accidents.

- Conduct further study on the causes of accidents and ways to prevent them through such mechanisms as EPA's Accidental Release Information Program, which focuses on the causes of chemical accidents and prevention methods and is currently being pilot-tested. This information must be shared with the SERCs, LEPCs, industry, professional and trade associations, and the public. The studies should address the rationale for using specific technologies and techniques, the effects of liability on industry practices, and other important issues.

- Encourage industry and professional and trade associations to continue to improve the state of practice and conduct research that will develop and refine cost-effective, reliable prevention, monitoring, detection, and public alert methods, procedures, and devices. Encourage a continuation of the research at the Department of Energy (DOE) test facility on the behavior of dense gas releases. Suitable means for transferring the results of the research to users should also be developed.

- Develop guidance, where warranted, in areas such as the use of in-place sheltering, hazard assessment, successful management approaches, appropriate use of real-time dispersion modeling, and methods for dealing with hazards.

- Enhance Federal and State expertise in the field of chemical process safety by working with other agencies to develop training for the conduct of facility audits in this area. The Agency will continue to investigate accidental releases of hazardous chemicals in cooperation with other agencies such as the Occupational Health and Safety Adminstration (OSHA), the Nuclear Regulatory Commission (NRC), and FEMA.

- Work with international organizations to identify and draw upon their expertise in the causes of accidents and to share information on hazardous chemicals, modeling, and the causes of accidents and ways to prevent them. The recent agreements reached at the High Level Conference on Accidents Involving Hazardous Substances under the auspices of the Organization for Economic Cooperation and Development laid the foundation for this work.

4. MANAGEMENT

The commitment of management to accident prevention, mitigation, and preparedness is essential. Without such commitment, installation of the most advanced technologies will be an expensive, but ineffectual safeguard for preventing serious injury, death, or environmental damage.

While accidents can occur in well-managed facilities, the lack of management commitment can lead to disaster. Accident investigations have discovered incidents where the releases occurred because managers ordered operators to use equipment in ways that directly conflicted with posted procedures. Part of management's responsibility is to train workers to operate equipment properly. The lack of management commitment to safety is evident in the cases where releases have been the result of inadequately trained operators. The best equipment can be extremely dangerous in the hands of untrained workers.

4.1 MANAGEMENT PRACTICES

The ultimate responsibility for the safe design, operation, and maintenance of a facility rests with management. A comprehensive management approach to accident prevention begins with the choice of the site, equipment, process, and design, and continues throughout the operation of the facility. A comprehensive approach must include up-to-date operating procedures, training programs, regular maintenance schedules, the use of recognized hazard evaluation methods, and an active involvement with the community.

This section outlines key elements in a comprehensive program, then discuss some of these in greater detail in light of the findings of this review.

4.1.1 Key Elements in Management Programs

Several organizations, both professional and industrial, have outlined programs to define good management practices for the construction and design of facilities, and for production, processing, use, and storage of hazardous substances. The components of such programs include, among others, the following items:

1. Capital project review and design process review should be conducted to analyze all designs for safety problems before they are approved; this can include preliminary hazard assessments as well as pre-start-up safety inspections. Human factors, such as the ease of operating equipment, should be considered in the design of the system.

2. Management must recognize that compliance with standards and codes of industry, associations, and laws of governments is a minimum, and the intent of these standards must be applied on a case-by-case basis. Compliance with standards alone does not ensure a safe operation.

3. Process safety information should be documented to provide identification of the hazards, a description of key design data, and technical specification of each step of the path to a safe operation. This document should include rules and procedures for a safe operation.

4. Accountability of personnel involved in the operation of the facility should be defined.

5. Risk management should include identification and evaluation of potential hazards using valid hazard evaluation techniques. These must be regularly scheduled hazard evaluations involving key personnel, not just weekly or monthly inspections.

6. All process and facility changes should be evaluated for their impact on safety; each process or facility change should be subjected to the same rigorous review as would be applied to a new process. Authorization for change should include new operating procedures, training, and maintenance schedules.

7. Process and equipment integrity should be checked by periodic testing and inspection; this includes quality assurance.

8. Prompt investigation of all serious and potentially serious incidents should determine the cause(s) of the incident. The investigators should make recommendations for corrective actions.

9. Training, including testing and refresher courses, should be provided to all workers.

10. Audits of key elements should be conducted by technically qualified personnel; deficiencies and corrective actions should be documented.

11. The facility should have methods to enhance its knowledge of process safety; that is, the facility should have a method to increase knowledge about the processes and equipment.

12. Emergency procedures should be in place to respond to a release and to contact the local community. The facility should also have ongoing programs of communications with the community.

The required level of detail in the above elements needed to create a safe operation will vary with the chemicals, the size of the facility, and the complexity of the process. In addition, the overall effectiveness of a management system that contains all of the above elements will depend on the commitment of the managers to comply with both the letter and the spirit of each of the elements and any other elements that may be needed.

4.1.2 Safety Management Organization

A variety of ways exist in which to organize a facility to ensure chemical safety. Some facilities establish separate safety departments; others designate safety officers; still others delegate the responsibility to a number of departments. Some facilities that responded to the questionnaire stated that safety was everyone's job. Because it is management's commitment, rather than its structure, that ensures safety, there is no "best" organizational structure.

The expert panel on management reviewed the facility questionnaires to assess qualitatively the degree of management awareness and commitment to safety. The panel looked at the reports on training, accident investigation, appreciation of the hazards involved, management response to these hazards, and management involvement. For about a third of the respondents, the expert panel felt the management approach seemed consistent with "setting goals and measuring achievements," two key elements of quality management in any area, including safety.

About a quarter of the respondents did not seem to appreciate the risks involved, although in some cases, those risks may have been small. Therefore, the panel was uncomfortable with the degree of management awareness of risk for a significant minority of responding facilities.

For many facilities, especially among the smaller companies, safety appears to mean worker safety rather than loss prevention. When asked about protection systems, these facilities listed items such as respirators rather than technologies such as scrubbers. For these facilities, management must be made aware, through training and other means, of the possibility of major releases and the importance of management in preventing such releases.

4.1.3 Training

For safe operation and maintenance of a facility, employees must be trained in operating procedures related to their particular work, safety measures for handling the specific chemicals, fire and accident procedures, and emergency response measures. While 135 of the 146 facilities responding to the questionnaire train their employees, internal, formal training programs appear to be limited to the larger facilities. It should not be concluded that less formal training is necessarily any less effective. In small operations, a one-on-one training format may be the only feasible method and could be more effective.

All the reporting facilities that handle the more hazardous air toxics, such as phosgene, hydrogen cyanide, and methyl isocyanate, provide training and equipment to address emergencies. Where fire protection is relevant because of flammable chemicals in use, virtually every respondent offers training programs and regularly scheduled drills. Only 15 of the respondents reported training in hazard evaluation/loss prevention; one of the 15, a chlor-alkali facility has developed an in-house training program to teach hazard evaluation techniques to management and operating personnel.

The findings from the survey are supported by the information EPA has collected through its Accidental Release Information Program (ARIP), which has established a data base on the causes of accidents as well as on actions taken to prevent recurrences. An overwhelming number of the ARIP respondents cited training of operators as a release prevention measure.

4.1.4 Maintenance

While preventive maintenance is always preferred, it seems that preventive maintenance for critical elements is not universally or consistently applied at facilities that handle, use, or store hazardous chemicals. More than a third of the facilities that returned questionnaires reported that they have no preventive maintenance program. In addition, many of those that do preventive maintenance evidently do it for a limited range of process equipment and not on a scheduled basis. While a few facilities reported using techniques such as ultrasonic inspections to find "hot spots" in their pipelines, other facilities stated that pipelines do not need inspections.

4.1.5 Accident Investigation

Investigation of accidents and near misses can provide important information on flaws in process design or operation and should produce clear recommendations for improvements. This appears to be generally understood in the chemical industry although a number of facilities reported that they investigated only those accidents in which people were injured or a discharge permit was violated.

Most of the facilities that responded to the questionnaire use formal accident investigation procedures. Almost all reported that they had modified equipment or operations following the investigations and that they perceived improvements from the changes. Because of apparent liability concerns, industry is reluctant to share accident investigation information, which could help prevent accidents at other facilities.

4.1.6 Interactions with Outside Organizations

Participation in the Chemical Manufacturers Association's Community Awareness and Emergency Response Program (CAER) or related industry or public programs reflects the facility management's outward commitment to safety. Almost all of the chemical producers that responded to the survey reported involvement in programs such as CAER or local cooperative agreements with other companies. On the other hand, the survey indicated that users and distributors are more likely not to participate in industry programs. The same pattern was evident in answers to questions on involvement with LEPCs and local communities: chemical producers showed a higher relative involvement in the more sophisticated emergency coordination and exercise participation activities; users, storers, and distributors reported relatively little coordination.

4.2 DEVELOPMENT AND DISSEMINATION OF MANAGEMENT TECHNIQUES

Since Bhopal, the large chemical producers, trade associations, and professional societies most directly involved in the safety of chemical production processes have demonstrably increased their efforts to address large-scale problems of chemical safety. Many of the larger companies have conducted intensive internal reviews of technologies and management practices and corrected problems. These companies as well as the trade associations have attended meetings and symposia on the subject of risk management and safety practices. This type of meeting is important because, whereas CAER deals with external relations, these gatherings deal with internal issues of risk management. The effect of the Bhopal tragedy and other accidents has been less marked on smaller chemical producers and on distributors and handlers. In reviewing attendance at prevention symposia it appears that these companies are far less likely to participate in professional organizations and public meetings on safety.

Scientific management techniques are studied within the fields known as operations research and management sciences. Since the 1940s techniques have been developed in many areas potentially related to chemical safety, including production scheduling, inventory control, management information systems, and decision-making under conditions of risk and uncertainty. However, professionals in management science have paid scant attention to the issue of managing loss prevention in the chemical industry. In a recent 18-month period, fewer than one percent of the presentations at meetings and symposia on management dealt directly or indirectly with chemical safety.

Areas where the work of management science could be extended to more facilities handling hazardous chemicals include:

- The organization and control of production processes -- risks of chemical releases should be factored into the design and daily operating decisions;

- Inventory control -- the adverse effects of accidental releases should be reflected in the cost equation;

- Quality control and quality assurance -- situations that can lead to a release are fundamentally similar to situations that can lead to an inadequate product;

- Facility location, design of distribution systems, and the layout of the facility -- while long focused on balancing costs, these are also relevant to preventing releases; and

- Use of decision analysis tools -- these approaches can be used to consider the possibility of accidents in the plans and operations.

Some managers who responded to the survey did not have a clear appreciation of the hazards in their operations. Studies on decision-making practices of managers in general have found that:

- Most managers ignore the least probable options, no matter how large the consequences (positive or negative); and

- Most do not consider the possibility of several improbable options occurring at once, and generally focus only on the seriousness of the outcome. As a result of this narrow view, the managers do not look at the low-probability, high-risk events.

This finding is in line with the attitude that "it can't happen here." The challenge is to overcome this attitude. The chemical disasters of the past several years show the necessity of considering the worst possible case; most disastrous accidents would not have been considered credible before they occurred.

4.3 RECOMMENDATIONS

- The message on chemical safety and its management must be disseminated to users, handlers, and producers of chemicals, especially the smaller facilities.
- Management should be trained in the area of hazard evaluation and accident prevention.
- Wider study of management techniques should be encouraged; successful management approaches and models should be made available to chemical producers, users, and handlers, especially to smaller companies.
- Mechanisms should be developed to make users, handlers, and distributors more aware of risks and risk management. Title III mechanisms are appropriate for this because they compel the facility to examine their operation and convince the local community that they are operating in a safe manner.
- Guidance on training and maintenance should be developed.
- Mechanisms should be developed to collect, analyze, and disseminate accident investigation information. Industry should be encouraged to share this information. This practice has been limited in recent years by liability concerns.
- EPA must work closely with OSHA and other agencies such as NRC to foster prevention initiatives. These can include participation in chemical process safety audits and the development of guidance and guidelines.

5. PREVENTION SYSTEMS

This chapter discusses the techniques and technologies available and in use for the prevention and mitigation of accidental releases of extremely hazardous substances. These technologies and techniques can be divided into three categories: hazard evaluation techniques, pre-release prevention techniques and technologies, and mitigation technologies.

While this chapter focuses on technologies and techniques, prevention does not depend on a single piece of equipment or a single technique. Prevention must be part of a comprehensive, integrated system that considers the hazards of the chemicals involved, the hazards of the process, the hazards to the community, and the capabilities of facility personnel. None of the elements should be considered in isolation nor should any single technical solution be considered a complete solution to a particular problem. Each change in a facility, process, or procedure will have multiple effects that must be assessed in the context of the entire operation.

The systems covered in this chapter include technologies such as process control instrumentation, specific designs of process vessels and the process line, as well as techniques for identifying hazards and critical elements in a process. Prevention systems also include factors such as facility siting and layout, and management procedures such as training programs. Because a wide variety of technologies exist, especially in the pre-release prevention area, this review does not focus on particular technologies, but instead presents an overview of prevention systems based on information collected through the literature search and supplemented by the responses to the facility survey.

5.1 HAZARD EVALUATION

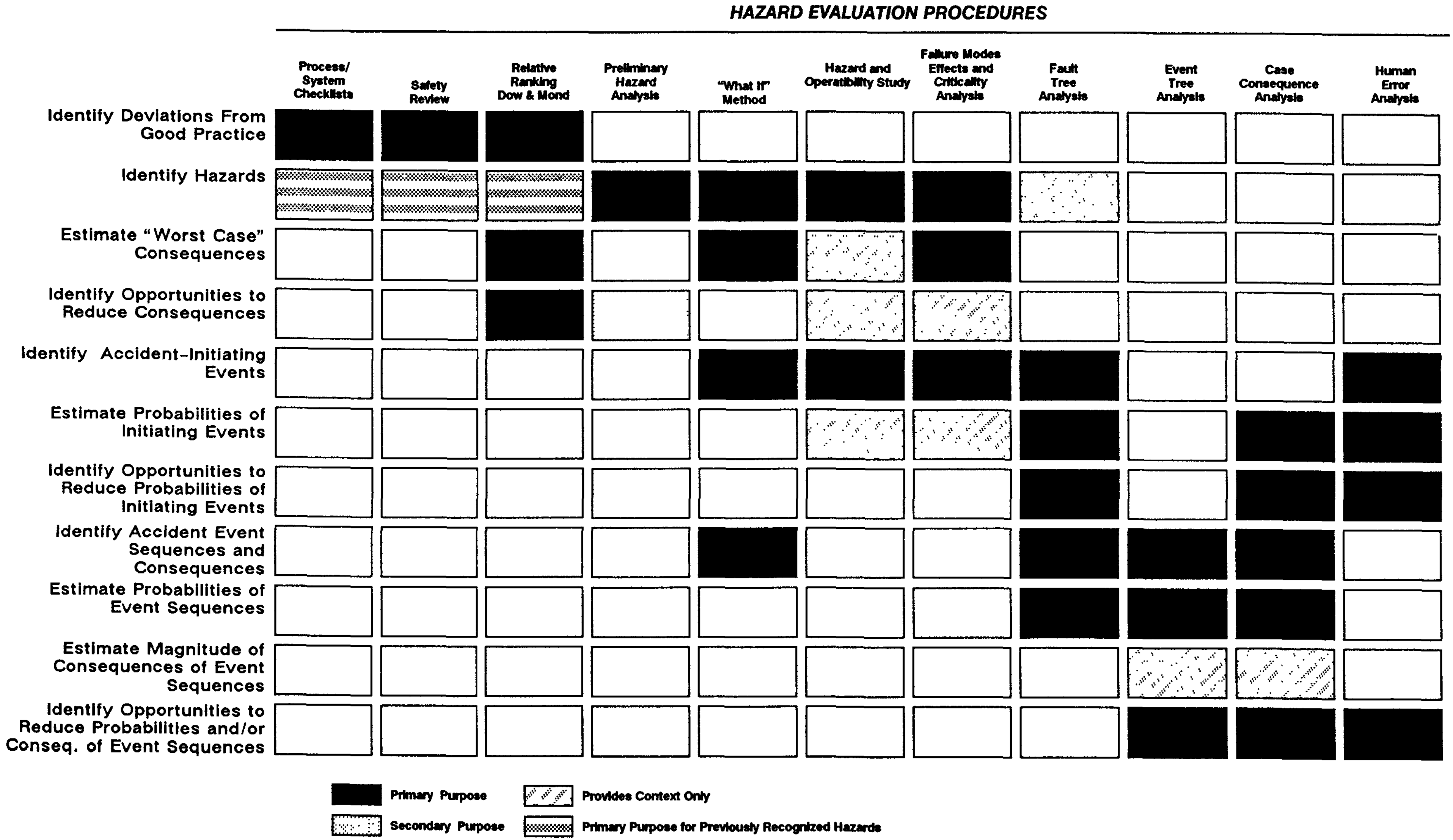
Hazard evaluation techniques are formal procedures employed to identify potential risks that could lead to an accidental release and, in some cases, to evaluate the probability of an accident and its potential effects. Hazard evaluation procedures provide a means of identifying needed changes in process design, operation, or monitoring. For process lines, hazard evaluation methods can help identify the critical elements that may need to be modified to incorporate redundant or back-up systems.

The American Institute of Chemical Engineers (AIChE) has published a report, <u>Guidelines for Hazard Evaluation Procedures</u>, which identifies eleven formal, qualitative, recognized techniques and describes the capabilities of each as well as the situations in which they are appropriate. These eleven techniques identify the hazards at a facility or in a process. The applicability of any particular technique depends on the size and complexity of the facility and on the level of risk involved. The eleven techniques are described in Appendix 3. Exhibit 5-1 shows the applicability of these techniques in a thorough hazard evaluation process.

Another type of hazard evaluation is <u>quantitative</u> risk assessment, the most highly detailed of which is probabilistic risk assessment (PRA), used in the nuclear power industry. PRAs use generally recognized methods, such as fault tree analysis, to quantify the probability of a release, and use source

Exhibit 5–1

Hazard Evaluation Procedures



Source: The Center for Chemical Process Safety, American Institute of Chemical Engineers. Guidelines for Hazard Evaluation Procedures. Prepared by Battelle Columbus Division. New York, New York, 1985.

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term models, dispersion models, and health effect models to predict effects on the populations exposed. Probabilistic risk assessment is the most costly and time-consuming of the hazard evaluation procedures.

PRAs are not recommended for every facility. Many operations do not need a quantitative method such as a PRA to identify hazards thoroughly enough to take steps to address those hazards. For facilities with complex processes, PRAs can be useful for comparing the effects of using different technologies, but in their current state, the quantification may be meaningful only for qualitatively assessing the relative level of risk; that is, the PRA can be used to compare the level of risk between two technologies, but not to define an absolute level of risk.

The accuracy of a PRA depends on the availability of reliable data on the actual causes of accidents and on equipment failure rates and human error rates. These data are not, at present, sufficiently reliable. Ideally, data on equipment failure rates should be specific to the facility, process, and operating procedures; at this time, however, most of the data are derived from data bases that are less specific. Despite these limitations, quantitative methods such as PRAs can help define where data are needed and can be used to examine the effects of data gaps on the analysis of risks. The AIChE plans to publish guidelines this year on quantitative risk assessment procedures and on obtaining process equipment reliability data.

The facility questionnaire responses indicate that ongoing efforts to inform chemical facilities about hazard evaluation techniques need to be expanded. Although almost all of the respondents stated that they use hazard evaluation methods, only half are using AIChE-recognized techniques. The other facilities listed less formal techniques or techniques not generally considered to be hazard evaluations (such as hazard committees and safety training). Some facilities listed recognized techniques such as safety audits and checklists, but stated that they conducted them daily, weekly, or monthly, which indicates that they are simply routine safety inspections rather than formal hazard evaluations. In general, many facilities seemed to equate hazard evaluation with routine safety measures. This finding indicates that, beyond disseminating information on accepted techniques, the terminology used in this area should be standardized.

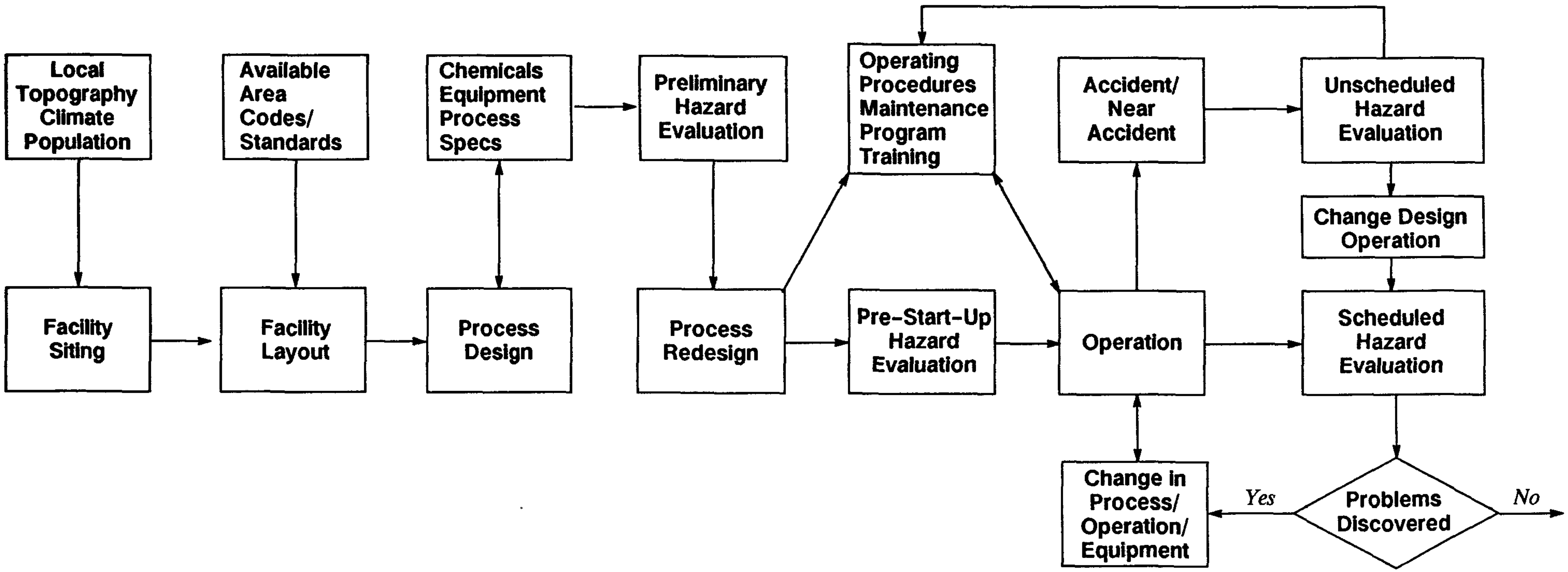
5.2 PRE-RELEASE TECHNOLOGIES

Pre-release prevention or loss prevention technologies are designed to reduce the probability that the primary containment of the chemical will be breached. Pre-release prevention includes such factors as facility siting and layout, as well as prevention technologies. The overall prevention process is diagrammed in Exhibit 5-2.

The use of particular technologies is site-, process-, and chemical-specific. The technologies can be either intrinsic -- integral to the design of the facility and process line -- or extrinsic -- supplemental to the process technologies in place. While the use of appropriate technologies is essential, the safe operation of a facility is the result of a complex and interlocking set of factors in which not only technology, but also management practices, play critical roles. The best technologies available will not be

Exhibit 5–2

Prevention Process



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adequate if they are not safely maintained and operated, which results from an overall management commitment to safety.

5.2.1 Siting and Facility Design

As was discussed in the Interim Report, the siting of a facility and its layout can affect the degree of risk that a release of extremely hazardous substance may pose to the surrounding community. Since the majority of the facilities that responded to the questionnaire were at least 15 years old, survey respondents were usually unable to provide information on the criteria used during the initial stages of the facility's development.

Residential or commercial development that occurs after a facility is built can increase potential risks. Some of the facilities that responded to the survey identified process changes that were made because of changes in the local community.

As stated in the Interim Report, a number of widely accepted codes, standards, and recommendations provide minimum safety standards for equipment design, procedures, and systems. It should be stressed that these standards and codes are minimums. Management must understand the degree of protection provided by the standards; for the most part, meeting the minimum safety requirements is not sufficient for facilities handling extremely hazardous substances.

5.2.2 Process Design

The number of possible approaches to limit accident potential is so great that the ability of a system to prevent releases can only be appraised through inspection by experienced technical personnel or by a detailed hazard evaluation. However, regardless of the specific equipment used in a particular process line, it is important that, for critical elements, the process line include redundant systems, backups, and interlocks (an automatic shutdown of a process if a critical piece of safety equipment becomes inoperative). For example, emergency power and cooling systems can prevent releases if the primary systems fail. EPA's ARIP data base indicates that such emergency backup systems may not be widely perceived as necessary; very few ARIP respondents reported installing such systems after a release. Appendix 10 provides a summary of ARIP's initial findings on release prevention and post-release measures.

Process design changes that may serve to prevent releases include the substitution of less hazardous chemicals, reduction of the severity of process condition (e.g., temperature and pressure), reduction of process complexity, and improved operation and safety procedures and training. Many of the surveyed facilities cited the installation of hardware within the process as an action taken to minimize the frequency and severity of emergency releases. An ammonia facility upgraded flares, decreased its inventory, eliminated pressurized transport, and installed pipeline isolation valves; as a result, its reportable releases decreased from 12 per year in 1982 to one in 1987. A phosgene facility upgraded its process control system from analog control to computerized, direct digital control with interlocking safety/shutdown logic; the facility noted a significant reduction in accidental releases.

A few facilities such as the ammonia facility reported the reduction of inventories of hazardous chemicals; one reported modifying its process to completely eliminate the storage of one chemical. Among facilities handling extremely hazardous substances, there appears to be a trend toward smaller storage facilities.

5.2.3 Process Control and Monitoring

Process control and detection capabilities are necessarily dependent on the chemical and the complexity of the process. (The monitoring and detection devices referred to here include the instrumentation and other controls on the process line itself, rather than detection devices at the perimeter of the process area.) The process hazards most commonly identified by respondents are overpressurization, runaway (exothermic) chemical reactions, fire and explosions, and overfilling vessels. Many of the controls and detectors used to monitor these hazards are the standard equipment used to control pressure, temperature, and flow. In addition, although not directly related to process monitoring, corrosion monitoring (using probes or ultrasound testing) and vibration detection are important in the prevention of accidental releases. Appendix 5 provides examples of prevention and protection methods for the chemicals considered in this review.

While the facilities responding to the questionnaire cited a number of areas in which they use process monitors, many of these appear to be designed for routine monitoring rather than specifically for detecting accidental releases. Routine process monitors can be very effective as leak detectors, if properly placed and maintained. For example, a sudden pressure drop may indicate a vapor leak in the system and can be the first warning of a problem, even before air monitors detect a cloud. Of the 67 facilities that reported using leak detectors, most were handling gases or highly volatile substances.

Although methods for detecting a disabled control device and back-up systems may not be the primary focus of prevention, they are important because the operators need to know when control devices, which are a front-line defense, are not functioning. Most of the respondents have some way of detecting disabled controls, with monitors, operator observation, and routine inspection being most commonly used. Fewer than half of the respondents, however, appeared to recognize the need for redundant controls. For example, a chlorine packaging facility handling large amounts of chlorine in a moderately populated area reported that it has no back-up systems for pressure sensors used for process monitoring; the facility relies on routine inspection to detect disabled control devices.

5.2.4 Protection

Pre-release protection is the application of equipment, systems, and procedures to capture, neutralize, or destroy a toxic chemical before it is released to the environment. The types of pre-release protection measures needed at a facility depend on the specific hazardous substances present and the surrounding environment that their release could affect. The measures can be applied only when the released chemical is confined, when it can be transported into properly sized control systems, or when circumstances allow remedial actions to be taken.

Pre-release protection measures applicable to potential releases to surface soil and water from storage tanks and process equipment include maintaining back-up pumps or secondary structures to remove or contain discharging liquids, possibly followed by treatment of the substance. For reactive or soluble gases and vapors, two common protection devices are emergency scrubbers and flares. Scrubbers employed as a protection measure usually use water or aqueous mixtures with specific scrubbing reagents. Chemicals such as ammonia, chlorine, hydrogen cyanide, hydrogen fluoride, hydrogen sulfide, methyl isocyanate, phosgene, sulfur dioxide, and sulfur trioxide are readily amenable to scrubbing. Flares are an appropriate measure for flammable gases and vapors, but generally not an appropriate measure for streams producing highly toxic or acidic, corrosive combustion products.

The responses to the questionnaire indicate that scrubbers are used by a significant number of facilities. Flares are not as widely used as scrubbers. Whether scrubbers and flares are an appropriate protection method, however, depends on the process involved. It was difficult to determine from the survey responses whether the facilities not using them fail to do so because they are not appropriate or because the facilities do not recognize their potential usefulness. Only the largest facilities have stand-by scrubbers to be used for accidents. Other facilities have scrubbers available to mitigate routine releases; these scrubbers may be able to mitigate accidental releases. In general, flares are likely to be found only at large facilities or facilities handling large volumes where the subject chemical would be flared in a mixture with other flammable gases and vapors. Flares appear to be used particularly by facilities handling acrylonitrile, ammonia, hydrogen cyanide, hydrogen sulfide, and phosgene.

5.3 POST-RELEASE MITIGATION

Post-release mitigation measures are used when a loss of containment has occurred, but while the extremely hazardous substance is still within the facility perimeter. They serve to reduce the extent to which the substance migrates off-site by reducing the quantity or concentration of the substance to which people would be exposed. Effective mitigation applications are very specific to site, location, substance properties, process characteristics, and scale of operation. Uniformity and consistency in the application of any one mitigation technique is, therefore, neither expected nor desired.

Mitigation measures can be applied to some atmospheric releases of vapor and gases as well as to liquid spills to soil and surface water. However, mitigation is effective and viable only for some release scenarios; in many situations, mitigation systems are not technically feasible.

The unconfined nature of large vapor releases and the short response times renders mitigation of such releases difficult. If the release results from a total containment failure with an instantaneous release of all material (as opposed to a gradual release), the chemical cloud usually moves beyond the perimeter before any mitigation measures can be activated. For such scenarios, concentration on ways to prevent the release is vital.

Although water sprays and curtains are used, their effectiveness for vapor releases has not been demonstrated on a large commercial scale. To design and evaluate a mitigation measure requires full-scale testing with varying meteorological conditions; this testing is very costly, requiring expert personnel, instrumentation, data analysis capability, and a special site (for example, the DOE testing site in Nevada).

Liquid releases can be large and instantaneous as well, as was demonstrated in the recent fuel oil release into the Monongahela River in Pennsylvania. In many cases, however, where the released chemical is a liquid with a low vapor pressure, properly designed dikes, pits, and dikes in combination with measures such as foams that limit volatility can contain a release.

Two-phase releases, where both liquid and vapor result, require a combination of liquid phase and vapor phase techniques, applied simultaneously. Because the vapor phase techniques are of limited usefulness in many cases, one goal of two-phase mitigation is to prevent the chemical from vaporizing. For unconfined, two-phase releases, the effectiveness of the technologies -- foams, absorbents, reactants, physical covers, and water sprays/fogs/curtains -- is unproven for large-scale releases.

Solid releases are usually considered less of a hazard to the public because solid particles require greater energy to become airborne and do not have the same natural buoyancy as gases and vapors. Water sprays, fogs, and curtains may be an option for these releases, but the technology for mitigating these releases is relatively undeveloped.

5.4 RECOMMENDATIONS

- For extremely hazardous substances, emphasis and resources should be placed on pre-release prevention rather than on post-release measures.

- Information on prevention as a comprehensive, holistic approach should be disseminated to smaller companies.

- Information on the applicability and limitations of hazard evaluation techniques should be widely disseminated and the terminology in the hazard evaluation area should be standardized.

- A mechanism should be developed to improve the data on equipment failure rates and human error rates. The government should work with standard-setting professional organizations to improve the understanding of the data.

- Research should be conducted on mitigation technologies for liquid, two-phase, and solid releases. Mitigation technologies for large-scale releases should also be evaluated.

- Information on the design and effectiveness of protection devices, focusing on operation under emergency conditions, should be developed and disseminated.

6. MONITORING AND DETECTION SYSTEMS

This chapter discusses detection systems used to detect releases in the process areas of a facility, and monitors used outside the facility, either at the perimeter or in the community. In addition, the chapter discusses air dispersion models that have been developed to predict the movement and concentration of releases of extremely hazardous substances.

Detection systems are integral to a facility's emergency response capabilities. By using these systems, releases can, in some cases, be detected sufficiently early to prevent catastrophic results. There are four basic process area detection systems: observation by operator, multi-detector systems, fixed detector/multi-sampling point systems, and remote sensing systems.

Monitoring of ambient concentrations is used to determine the impact of a release and the distances to which local residents must be evacuated or within which residents must be asked to remain indoors. Monitoring is also used to determine when concentrations have decreased sufficiently to allow re-entry into the area. Congress specifically directed the Agency to examine the technical and economic feasibility of perimeter alert systems, detection systems deployed around the perimeter of a facility. The review also looked at two systems used in the field: portable monitoring instruments and field laboratories.

This chapter provides an overview of the current status of technological capabilities of monitoring and detection systems and discusses the general factors affecting the decisions to install the various technologies. Emphasis is given to systems used to detect and monitor the movement of a plume formed by chemicals that are released into the air. Releases to surface and ground water, which pose less immediate threats to public health and the environment, are monitored by long-established techniques; monitoring and detection of these releases were covered in the Interim Report. This chapter also discusses some of the general limitations of the technologies and of the use of existing dispersion models.

6.1 DETECTION TECHNOLOGIES

6.1.1 Observation by Operator

The primary method industry uses to detect releases is observation by process operators and other personnel; observation includes monitoring of instruments as well as seeing, hearing, or smelling a release. At many plants, personnel are required to conduct inspections on a regular basis using checklists. In some plants, video camera surveillance augments the inspections.

The primary reason for relying upon observation is that personnel present at the facility may detect a release before it becomes serious. Experienced, trained personnel can recognize a release situation before the release would trigger any instrument. The main disadvantage is that this approach may result in short-term exposures of humans to the released chemical. Relying on observation by operators may also place unrealistic demands on human performance. However, observation continues to be the prime method because, for some chemicals such as ammonia and chlorine, the human senses of smell, taste, and sight are much more sensitive than any instrument now available and are also more reliable.

For chemicals such as phosgene that do not have an appreciable or disagreeable odor or do not cause irritation prior to reaching concentrations of concern, an instrumentation-based detection system is needed to prevent releases from remaining undetected until it is too late to initiate protective action. For some chemicals such as hydrogen sulfide, which has a strong odor even at safe levels, instrument-based detection systems are also needed because the chemical destroys the sense of smell as it reaches acute levels. In all cases, facilities should consider detection systems to reinforce observation.

6.1.2 Multi-Detector Systems

Multi-detector systems involve the placement of a number of real-time detectors at selected locations throughout a process area. When one set of detectors senses that chemical concentrations have exceeded a set level, an electrical signal triggers a visual or audio alarm. There are two types of multi-detector systems: general parameter devices (e.g., hydrocarbons, combustible gas detectors) and compound-specific devices. The general parameter detectors respond to a wide variety of chemical compounds and are used in areas where it is unlikely that any compounds other than those of concern will interfere with detection.

Compound-specific devices produce electrical signals that are directly related to the concentration of a single compound. There can, however, be interfering compounds present that will either cause a response or inhibit the response of the device to the target compound. Therefore, this type of device is used only where there is little chance of encountering interfering compounds. (See Appendix 6 for a description of specific detection devices.)

Multi-detector systems provide 24-hour detector availability. One disadvantage of the detectors is that a relatively large number of detectors may be needed to ensure that a plume of released chemical does not slip by the detectors. Another disadvantage is that many of these detectors are relatively insensitive and must be placed fairly close to the potential release point, thus limiting the size of the area they can cover. Additionally, they require regular maintenance and calibration.

Among the facilities responding to the questionnaire, those that use process area detection systems are generally using chemical-specific systems. The decision to install such a system depends on the perceived reliability of the system and its cost-effectiveness, both of which are site-specific. A small facility in a remote area may decide that the costs of the system are not justified because the result of a release will be negligible. The same size facility handling the same chemical in an urban location may decide a process area detection system is needed because of the potential consequences of an accidental release.

In general, to most surveyed facilities cost-effective means inexpensive, and reliable means dependable and easy to use. The more costly the systems, the less likely facilities are to install them. Reliability is usually seen in terms of the need for calibration and for monitoring of instrumentation by skilled technicians. For example, some chlorine detectors are calibrated at the factory and hold their calibration for months. Combustible gas detectors are affected by ambient conditions such as temperature and humidity and need continual adjustment. Another factor in reliability is the ability of the detector to function without false alarms. Some detectors can be triggered by other chemicals and others simply go off periodically for no discernible reason. Whatever the cause of the false alarms, any significant number of them can cause people to ignore or disable the alarms and, therefore, render the detection system useless.

For a number of chemicals, particularly chemicals released in solid form, no satisfactory detection systems exist. None of the facilities handling solids reported using detectors. In part, they may not use detection systems because many large particulates do not migrate very far and, therefore, do not usually create emergency conditions. An additional problem for particulate releases is that the available detection systems are costly and unreliable; most systems cannot distinguish between benign dust and particles of hazardous substances.

Highly corrosive chemicals, such as hydrofluoric acid, destroy detectors fairly rapidly. The materials that resist corrosion, such as stainless steel, do not make good detectors. For some chemicals, one possible solution in this area is to use the destruction of glass and plastic by the corrosives as a detection system. The rapid clouding of the glass would be the indicator of the release. For this method to be feasible, however, the detectors would have to be very inexpensive because each detector could be used only once.

For some chemicals considered, particularly ammonia, the facility questionnaire responses indicated a lack of awareness of the risks and of available detection systems. Ammonia detectors are reliable, but only four of the 25 facilities that use the chemical use detectors for air releases. Some facilities that use ammonia as a refrigerant do not appear to recognize the potential risk from releases of ammonia vapor. Because these facilities frequently contain large quantities of ammonia and are often unattended at night, information on the availability and capabilities of existing detection systems should be provided to them.

6.1.3 Fixed-Detector/Multi-Sampling Point Systems

Fixed-detector/multi-sampling point systems use a single detector or instrument. Samples from several process points are pumped to the instrument and introduced in rotation for analysis. This type of system is most often used when an expensive or complicated instrument or method of analysis such as gas chromatography is needed. The cost and complexity of the systems make it impractical to install a detector at each sampling point. These systems, usually installed to detect releases of organics, and also used to monitor releases of inorganic toxic gases, are becoming more common.

The sophisticated instruments used in fixed detector/multi-sampling point systems can be highly sensitive. The trade-off for the high sensitivity is the loss of continuous monitoring. Because individual sample lines are analyzed in rotation, each sampling point is not monitored continuously. For example, an individual analysis for each point often takes

1.5 minutes; if 20 points are monitored in sequence, each point is then checked only every half hour, which would make it possible for a plume to slip by the array undetected. Additional research and development needs to be done to develop systems that can sample each point at much higher frequencies. As with multi-detector systems, fixed-detector systems should be designed to require little calibration and maintenance.

6.1.4 Remote Sensing Systems

Remote sensing systems rely on a fixed-station detector, which receives optical signals from a released substance. A detector is placed within a potential release area and pointed at a light source. The detector measures the intensity of the light. When a chemical plume crosses the light beam, part of the light is absorbed or scattered by the molecules of the chemical, diminishing the intensity of the light reaching the detector. The detector then triggers an alarm.

While a few of these systems have been custom-designed for use in the detection of volatile chemicals, most commercially available systems have been designed to monitor dust levels in mines and concrete plants. These systems are relatively undeveloped for general use and are very expensive. Laser-based systems, now in the initial stages of development, hold the potential of providing an effective detection system because, in theory, laser systems could scan a facility for a specific chemical every 20 seconds.

6.2 PERIMETER MONITORS

Perimeter alert monitors are detection devices placed at the perimeter of a facility to detect releases that are moving into the community; they serve both to indicate that a release has occurred and to identify the direction. The latter is important in determining which areas may need to be notified first to take protective actions.

Perimeter monitors are usually fixed-point detectors and are basically the same as process area detection systems, except that they must have a higher degree of sensitivity because of the lower chemical concentrations that result from dispersion. Only eight of the facilities that returned questionnaires are using perimeter monitoring systems.

Facilities that have considered perimeter monitoring systems and decided against installation cite a number of reasons. A large facility would require an extremely large number of sensors to cover the area; this alone can make the system economically infeasible and difficult to maintain. Even for a small facility, the cost can be high, depending on the cost of the individual detectors. Exhibit 6-1 provides cost estimates for three perimeter alert systems for large and small facilities. Appendix 6 provides additional details on perimeter alert systems.

In addition to cost, respondents cited other problems that deterred them from installing perimeter systems: the concentration of the plume may be below the detection limit of the system by the time it reaches the perimeter

EXHIBIT 6-1

COST ESTIMATES FOR PERIMETER MONITORING SYSTEMS

	Estimated Cost per Monitoring Station		
	Fluorescent SO2 Analyzer	Photo-electric Tape Sensor[1]	Electrolytic Chlorine Detector
Equipment Cost	$29,000	$5,000	$5,000
Installation Cost	$6,500	$4,000	$6,000
Operating/Maintenance Cost (per year)	$8,400	$7,500	$1,600
Annualized Cost[2]	$13,000	$8,700	$3,000

	Estimated Total Annual System Cost		
	Fluorescent SO2 Analyzer	Photo-electric Tape Sensor*	Electrolytic Chlorine Detector
Estimated Annual System Cost for Large Facility[3]	$550,000	$370,000	$126,000
Estimated Annual System Cost for Small Facility[4]	$130,000	$87,000	$30,000

1. Photo-electric tape sensors can be used to detect chlorine, phosgene, hydrogen sulfide and ammonia.

2. Annualized cost is the annualized equipment and installation cost using a discount rate of 5 percent added to the yearly operating and maintenance cost. A system operating life of 10 years is assumed.

3. A large facility is assumed to have an area of 640 acres (one square mile), approximately 21,000 feet of linear perimeter, and 42 monitoring stations placed every 500 linear perimeter feet.

4. A small facility is assumed to have an area of 30 acres, approximately 5,000 feet of linear perimeter, and 10 monitoring stations placed every 500 linear perimeter feet.

and the topography of a facility may make it difficult to install perimeter systems. Respondents listed a number of benefits in having the detection system installed in the process area rather than on the perimeter. With a process area system, the chance of detecting the release early and of preventing greater releases is substantially higher. By the time a release has reached the perimeter, it has already reached the community. Process area systems are also more cost-effective because far fewer detectors are needed to provide adequate coverage.

One respondent reported an extensive investigation of a laser perimeter alert system. The facility identified at least three companies that are actively marketing laser systems to monitor for chemicals such as hydrogen sulfide, ammonia, sulfur dioxide, hydrogen fluoride, and chlorine. The facility found that the laser systems it investigated could provide real-time measurements of a chemical plume as it crosses the laser's path. Those systems had maximum monitoring distances ranging between 100 meters and 5 kilometers, with measurement sensitivity in the parts per million range. The respondent evaluated a prototype system and decided against it for several reasons: the technology was not considered reliable; the laser may pose vision safety problems; and the system is currently not economically feasible for a large facility.

6.3 FIELD MONITORING SYSTEMS

6.3.1 Portable Monitoring Instruments

Portable monitoring instruments, used outside the perimeter of the facility, are real-time, direct-reading instruments that one person can easily carry and operate. They are available as both general parameter and compound-specific detectors. The advantages of these instruments lie in their portability and real-time readout. Disadvantages derive from their limited sensitivity, from the difficulty of calibration, and from the possible exposure of monitoring personnel.

These systems are in use throughout the industry, in some cases to meet OSHA monitoring requirements. They are also used in some communities in emergency release conditions. In all cases, their usefulness is dependent on having an operator who knows how to use the instrument and how to interpret the data properly.

Robots that can examine an accident scene are being investigated for use in situations where the chemicals are extremely toxic. Robots have been used in highway accidents when the chemicals involved were either too toxic to risk human exposure or were likely to explode.

6.3.2 Field Laboratory Instruments

Field laboratory instruments are mobile lab units transported by van or bus. They can produce accurate, precise data on concentrations in air in the sub-parts-per-million range. The main advantage of field lab instruments is that they can quickly provide accurate data; their main disadvantage is that they are not widely available, must be transported promptly to the accident site, and require calibration at the site. For a field laboratory to be useful in an emergency situation, it must be maintained in a constant state of readiness. In addition, the instruments must be calibrated for the specific chemicals in the release, which requires that the people operating the lab know what those chemicals are.

6.4 DISPERSION MODELING

Dispersion models are computer-based simulation programs that predict the direction and concentration of a contaminant plume. Available models vary from general dispersion models to highly sophisticated, real-time, proprietary models.

At present, dispersion models are best used as training and planning tools. For these purposes, the simple models are adequate. The facility and community can model situations and vary factors such as the direction of the plume, the wind speed, and the time of day. With these various release scenarios the emergency planners can develop training exercises to respond to the different situations that would arise from the different scenarios.

Although half the responding facilities use some air dispersion model, a number indicated that in real-time emergency situations, the applicability of even the most sophisticated models is questionable. As with any model, the reliability of the results depends on whether all the variables that could affect the outcome are included and on the accuracy of the data used. Most models are based on Gaussian dispersion techniques and may include dense gas dispersion algorithms. However, the understanding of dense gas dispersion is relatively new and these gases may not behave in a Gaussian manner. (See Appendix 6 for a description of the models in use at responding facilities.)

The models currently in use do not adequately consider a number of key elements that could dramatically alter the release scenario. These factors include the dispersive characteristics of the chemicals, source strength, micrometeorology (i.e., local weather conditions), and heat generation (most chemical plants generate large amounts of heat, which disrupts the general airflow). Source strength (size, physical state, and rate of a release) is the hardest of these to determine in an emergency and is the most critical in all models.

The greater the reliance on model output for decision-making, the greater the need for validation and calibration of the model for the specific site. These validation exercises, however, are extremely expensive. They require data on source strength and release parameters, meteorological data, etc., over a sufficient period of time to cover the range of conditions that could occur. While the accuracy of the data is not critical for training purposes, in an emergency, if each necessary factor were off by ten percent (which is not unusual), the final prediction could be off by 50 to 100 percent. None of the models available can yet react to changes quickly and accurately enough to generate more than an estimate of the release.

The level of sophistication of models has increased rapidly in recent years and is likely to continue. Current models need to be validated and then calibrated for use at specific sites. In addition, data on source strength calculations and acute health effects need to be improved. The latter information is necessary to interpret the model. The current models are useful when used by an expert who realizes their limitations, but can be misinterpreted by someone not familiar with the underlying assumptions. The AICHE has recently published Guidelines for Use of Vapor Cloud Dispersion Models, describing the applicability and limitations of these models.

6.5 RECOMMENDATIONS

- Industry should be encouraged to conduct the research needed to improve the reliability and cost-effectiveness of detection systems. The emphasis should be on developing systems that are relatively inexpensive and that do not require frequent calibration or trained technicians to operate. Remote sensing systems (e.g., chemical-specific, laser-based systems) should be developed for more general use.

- Reliable, inexpensive, throw-away detection systems should be developed for corrosives.

- Dispersion models should be used in real-time situations only with great caution and then only by people aware of their limitations.

- Information on the capabilities and limitations of models should be further developed and disseminated.

- Further research should be conducted on source strength data and acute human health effects data. (International organizations are currently doing research, as are domestic companies and Federal agencies such as EPA, DOE, and the Department of Transportation.) This research is critical for understanding and overcoming the limitations of dispersion models.

7. PUBLIC ALERT SYSTEMS

Public alert and notification is a multi-phased process that begins with the detection of the release at the facility. If the facility determines that the release could migrate and affect the public, the facility contacts the local authorities. These authorities must then decide if and how to alert the public, and what actions to recommend. The components of these phases must be carefully integrated into alert and notification procedures that recognize the need for timely and effective communication. Exhibit 7-1 illustrates the public alert process. In an emergency situation, timing is critical; in rapid-onset events, the release could reach the public very quickly. Therefore, the public alert process must be prepared in advance to operate without delays.

The public response to a warning is a component that cannot be guaranteed. In many cases, hearing a warning is, in and of itself, insufficient to induce people to take action. A variety of factors that relate to the nature of the warning, the characteristics of the receiver, and the process of confirmation affect response. Public education is a key part of the public alert and notification process because it prepares people to understand what to do when a warning occurs.

This chapter provides an overview of the technologies and techniques available for alert and notification. Most of the information on procedures and technologies actually in use is derived from the community survey and from the expert panel. The data on the first phase of the public alert process is from the facility questionnaire.

7.1 TECHNOLOGIES

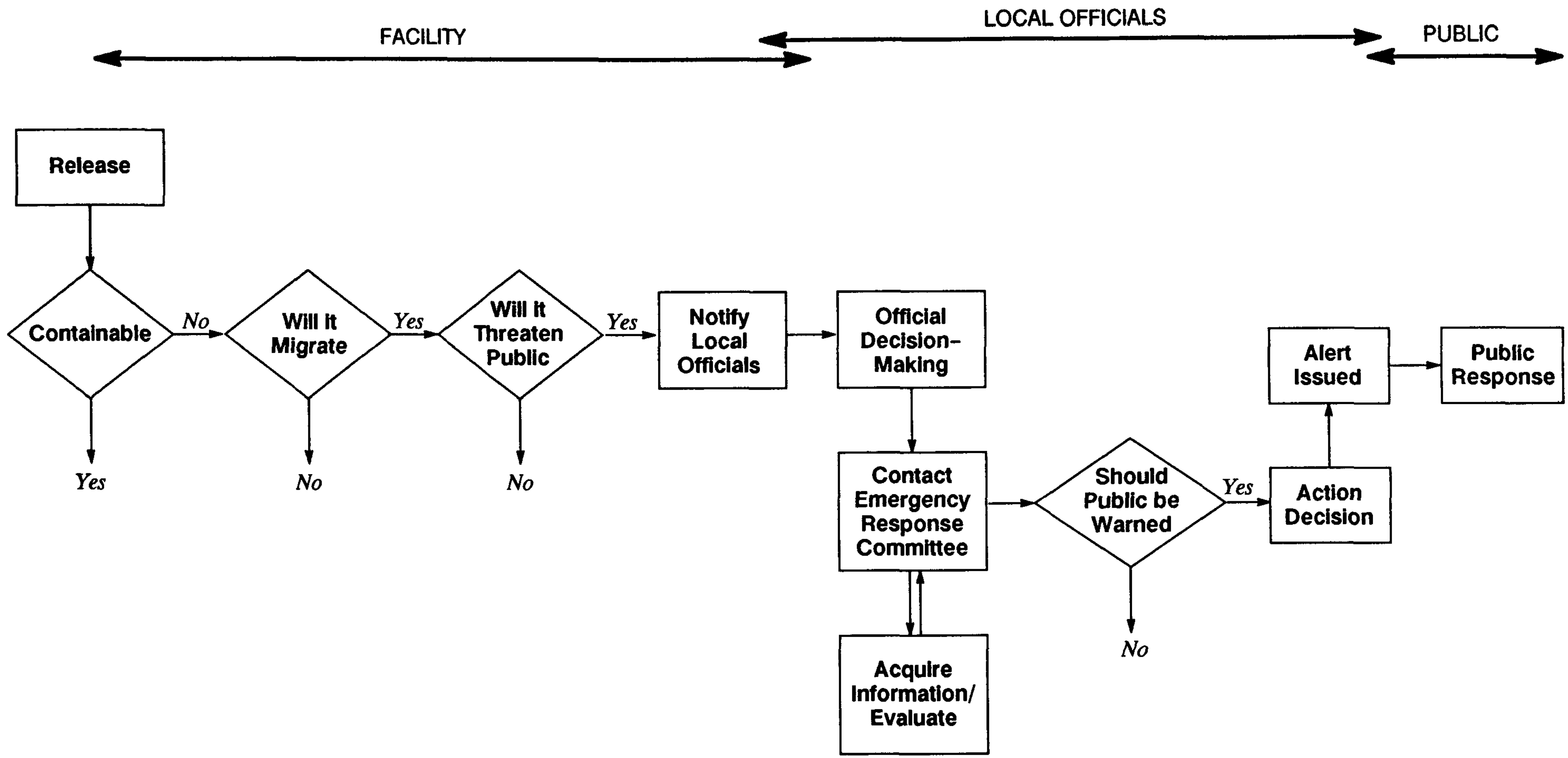
Public alert systems include two types of equipment: (1) communication technologies that facilities and communities use to exchange information and (2) technologies for alerting and notifying the public. The public includes residential, business and commercial, institutional, and transient populations.

Public warning systems can provide an alert, a notification, or both.

- An <u>alert</u> system provides a signal that something out of the ordinary is occurring that requires people to seek more information. Examples of alert technologies include sirens or alarms.
- <u>Notification</u> is the process by which people are provided a warning message and information. Examples of notification technologies include emergency broadcast systems (EBS), radio, television, and cable override.
- An <u>alert/notification</u> system serves both purposes. Examples of dual systems include tone-alert radios, telephone dialing systems, loudspeakers, and public address systems.

Exhibit 7–1

Public Alert Process



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Some systems, depending on how they are used, may not fall into precise categories. For example, helicopters equipped with loudspeakers are a dual system, but in reality typically do not provide notification because few people hear the broadcast message.

7.1.1 Communications Technologies

The initial step of the public alert process is the facility's notification of the appropriate community officials. The primary channels are commercial telephones and two-way radios. While these represent the most common forms of communication systems, experts do not consider them highly reliable. Telephones may fail (sometimes from the same event that caused the chemical accident) or may be busy. Two-way radios often operate at different frequencies, are found inoperable, or are difficult to use because of heavy traffic on the appropriate frequency.

The communication systems designed to overcome such problems -- dedicated telephone lines (a separate line not linked with commercial traffic), 911 telephone systems, dedicated radios, pagers, and special alarm systems -- are not commonly used in the communities surveyed. The main communications links, therefore, are the ones that frequently cause warning failures. This is not to say failure is certain, merely that advanced communications equipment exists in relatively few situations.

7.1.2 Alert Technologies

Sirens/Alarms. Although it may be expensive to install and maintain the systems, sirens and alarms can provide a relatively rapid alert to most potentially threatened populations. (See Appendix 7 for cost estimates of alert systems.) A few types of sirens have public address capabilities, but most only sound a noise, which limits their utility. While some communities have tried, in essence, to code alarms, so that a wavering tone means something different than short blasts, the public rarely differentiates among different alarm signals. Other problems that constrain the use of sirens and alarms are false alarms due to technical failures, equipment failures in emergencies, maintenance problems, coverage problems (particularly in adverse weather), difficulties in propagating sounds into buildings, and public indifference to sirens.

Modulated power lines. Warning systems exist that use alterations of the cycle-per-second frequency of regular electric power lines to activate a warning light, or a buzzer or siren. Many of the advantages of tone-alert systems, discussed below, hold for this type of warning device. However, modulated power line technology is relatively expensive to install, test, and maintain and it cannot be used if electrical systems fail.

Aircraft. In special cases, airplane and helicopters can be used as part of the warning process. Low-flying aircraft can carry sirens or bull-horns to provide an alert or warning message to remote populations or to people who cannot be reached by normal communication methods. However, this method requires access to aircraft and sound systems that can broadcast a message over the noise of the aircraft.

7.1.3 Notification Technologies

Radio. Radio is often used to disseminate warning information because it can reach a large number of people during non-sleeping hours. Certain radio stations have been designated Emergency Broadcast Stations as part of the National Warning System. Other radio stations broadcast warnings in most emergency situations as well. Prearranged plans accelerate the speed with which a radio warning can be issued.

One disadvantage of radio is that a broadcast covers areas not at risk. Second, all information must be conveyed verbally. Third, radio reaches only a small portion of the population during night-time hours. Fourth, because most stations are privately operated, problems can arise in priorities regarding warning broadcasts.

Television. TV stations can warn the public by interrupting normal programming or by displaying scrolled text on the bottom of the screen. TV reaches a large number of people, particularly in the evening hours. Like radio, it is of little use during sleeping hours. TV is particularly good for warnings of slowly developing events. One major advantage of TV is the ability to use graphic information such as maps or diagrams in the warning.

Cable Override. In many areas people have cable TV, which means that local stations play a lesser role in reaching the public. As a result, systems have been developed to broadcast a message of local applicability over all cable channels. Thus, a person in Cheyenne, Wyoming, watching a Chicago station or a movie channel, could still receive a warning of a Wyoming chemical emergency. The same advantages and disadvantages of conventional broadcast TV apply.

7.1.4 Alert and Notification Technologies

Personal Notification. Personal notification involves having emergency personnel go door-to-door or to groups of people to deliver a personal warning message. This warning mechanism can be used in sparsely populated areas, in areas with a large seasonal or diurnal population (such as a recreation area), or in areas that are not covered by electronic warning capabilities. The chief advantage of personal contact is that people are more willing to respond to a warning because they are more likely to believe that a danger exists. The disadvantage is that it is time-consuming to implement and may require the commitment of many vehicles and personnel.

Loudspeakers/Public Address Systems. Existing public address (PA) systems can be used to notify people in areas that are covered by such systems. Often schools, hospitals, prisons, nursing homes, sports arenas, theaters, or shopping centers have PA systems. In addition, portable loudspeakers in vehicles can be used to warn nearby populations and populations who have no other means of receiving the warning. They are particularly useful during night-time hours when many people are asleep. Their chief disadvantages are that it is often difficult for people to hear a warning broadcast from a moving vehicle and it is difficult for people to confirm the warning, particularly if they only heard a part of it.

Tone-alert Radio/Pagers. Tone-alert radios are specialized warning devices that can be remotely activated. Upon receipt of a code broadcast from a radio transmitter, the radio emits a tone and broadcasts a prerecorded or read message. The radio receivers operate on normal electrical power; some have battery backups. The advantages of the tone-alert systems include a quick dissemination time, the combination of an alerting signal with specialized messages, and round-the-clock availability. Disadvantages include maintenance problems, availability during power failures, and limited utility for warning people outdoors.

Telephone - Automatic Dialers. Two types of automatic dialers currently exist: switching and computerized dialing equipment. Switching technology has been developed that is capable of simultaneously calling hundreds to thousands of exchanges using automatic switching equipment. Some systems will automatically hang up phones in use and block out incoming calls during the transmission of the emergency message. These systems play prerecorded messages, which can be updated fairly quickly, or broadcast messages, providing timely information.

The chief advantage of telephone warning systems is the ability to disseminate a message quickly to people at home. Automatic dialing systems, however, are expensive and primarily limited in their use for that reason. (See Exhibit A 7-7 in Appendix 7.) Automatic telephone systems are currently used chiefly within an interorganizational network such as emergency response personnel or institutional facilities at risk. Recent developments make this an attractive option for small communities or for areas of a community where a prompt warning is needed.

7.1.5 Warning Systems in Use

Warning systems in use can be characterized as follows:

1. Enhanced systems that use sirens and some form of specialized alerting such as tone-alerts.

2. Siren-based systems that rely on sirens for alert with use of media-based notification.

3. *Ad hoc* systems that rely on media, EBS, and door-to-door or route alert.

Enhanced systems are capable of fast alert and fast notification. Siren-based systems have the potential for fast alert (based on coverage) with notification being more problematic. *Ad hoc* systems require more time to implement and reach the public with a message.

According to the responses to the community questionnaire, *ad hoc* methods are the predominant means to warn people in close proximity to chemical facilities. Siren-based systems are used in a third of the communities that responded to the questionnaire. A few use an enhanced system involving both sirens and tone-alert radios. All of these systems would be effective in an emergency with a 3- to 4-hour lead time or to support a precautionary response. In a rapid moving event, however, the majority of systems, including siren-based systems, are unlikely to provide an effective warning.

For institutional populations, communities are more likely to use tone-alert based systems, as well as the telephone. A lesser reliance is placed on ad hoc or sirens. Nevertheless, conventional systems are used in about one-half of the communities. A few of the communities have no provisions to warn institutional populations. Transient populations such as tourists are largely ignored as special populations requiring warning. The majority of the communities rely on ad hoc or siren-based systems to warn transients.

Few communities use the most sophisticated communications equipment or warning system technologies. It is clear that some communities do not need such equipment because the risk does not justify the expense. In other communities the differences are more critical because the potential risks are greater. Overall, the ability of the majority of systems to provide a timely alert and notification is questionable, particularly in a rapid-onset event.

7.2 FACILITY/COMMUNITY INTERACTIONS

Because, in many cases, the facility and the public officials will have very little time to act in a real emergency, there must be a dialogue between them beforehand to ensure that, should a release occur, both sides can move quickly. Specific individuals at the facility and in the community should be designated as contact points. The process is even more effective if each of the individual contact people has a designated backup. The communities and facilities that responded to their respective surveys expressed a similar level of knowledge about whom to contact: approximately three-quarters could name either the person or the position of the contact point.

Once a community's point of contact receives an alert, a notification process is set in motion within the community. Seldom does the person receiving the notification have, or take on, the authority to issue a warning to the public. The efficiency of the community response to the initial notification will determine the ability to provide an effective and timely warning.

A major factor determining the efficiency of the process is knowledge of what to do following the alert. Such knowledge may be reflected by a well-articulated description of the steps to be taken or by the existence of a standard operating procedure to follow after the notification. Uncertain knowledge, or, even worse, no knowledge of what to do will delay or impede an effective warning. About half the communities described clear procedures and half described vague procedures. Because almost two-thirds of the communities indicated they have a written warning plan or procedure, it appears some of the communities may not fully understand the contents of the plan or were poor in communicating the contents.

The facility survey addressed the decision-making procedures at facilities for determining when a release justified notification and for notifying communities about the release. The majority of facilities described rather vague procedures ("we'd call city hall") or did not describe procedures. Roughly one-third of the facilities responding to the survey have clear or standard procedures for decision-making and communications.

Public officials need to know more than just that an emergency exists to make a timely warning decision; they must have specific details on the nature of the incident. The warning to the public must contain clear, concise instructions on appropriate protective actions. Section 304 of Title III requires that facilities provide information to the community when they notify the community of a release. The information required includes the name of the chemical released, an estimate of the quantity released, the time and duration of the release, the medium or media into which the chemical was released, acute or chronic health risks and advice about medical attention for exposed individuals, precautions that should be taken, and the name and number of someone to contact for further information.

The survey indicates that many communities do not know what information to ask for in an emergency. The most common and frequently cited item of information needed by the community is the type(s) of chemical released or involved. The next most frequently requested information is the size or amount of material released and the risk to human health. Relatively few responding communities indicated a need for information on plume or release location, speed of dispersion, potential pathways, or protective action recommendations. Still fewer indicated the need for information on facility response -- what the facility was doing to control the event or whether community assistance was needed. Many, however, expressed a general need for information on what happened at the facility.

The next stage of the alert process is for the community to reach a decision about whether to issue a warning to the public. This may not be a single decision but a series of decisions regarding precautionary warnings, warnings to take protective actions, and warnings that the situation is not hazardous or that the emergency has ended.

Clearly defined procedures can lead to more timely and effective decisions, provided the appropriate officials are familiar with the plans. About a third of the communities surveyed have clear or standard procedures for making a warning decision. The remainder specified rather vague procedures and, in a few cases, no procedure. The lack of written or at least clearly defined procedures in the majority of the communities can be interpreted as another constraint to effective and timely public alert, which increases the probability of a warning system failure or a delay in issuing the alert.

Protective action recommendations are an important part of the notification procedure; the public expects guidance on what to do, not merely notification of the danger. Overall, the use of sheltering as a protective action strategy is not widely perceived as a viable option when compared to evacuation. A large number of communities have an evacuation-only philosophy, a lesser number a shelter-only policy. Such policies reduce the problems in decision-making, but may increase the threat to the public because evacuation may unnecessarily expose people to chemicals from which they could be protected by remaining indoors. In addition, in rapid-moving events, evacuation may not be a reasonable option. Research is needed to develop guidelines on when sheltering in-place should be recommended.

7.3 SYSTEM EFFECTIVENESS

Because the credibility of a warning message is crucial in the determination of public response, the source of the warning information is a critical element of the warning process. Emergency warnings are more likely to be effective when multiple sources of warning are indicated, and when local authorities, political as well as technical, are associated with the warning message. Among the communities that responded to the survey, there was a tendency to overidentify emergency managers and political or management positions as sources of warning and to underrepresent technical information sources.

Preparedness is achieved partly by having plans and procedures, and partly by "priming" the system. Priming includes testing equipment and public education. Pre-planned messages are also a sign of preparedness. The respondents test warning equipment on a fairly routine basis, with most reporting such tests weekly or monthly. Some communities even reported testing warning equipment and procedures daily, but a few reported testing warning equipment and procedures less often than monthly and some reported no testing at all. Written protocols for communications with the general public, via the EBS or the media, have been prepared in a third of the communities in the survey, and protocols for institutional facilities are available in less than one community in five. Few communities have protocols for foreign-language populations.

Although little evidence exists that public education makes a difference as to whether a warning system will function effectively, most respondents agreed that it contributes to an effective response. The majority of communities have either no public information program in place, or a poorly developed one.

Most of the communities report that the facility has provided information describing the hazardous chemicals used at the facility. Half of the responding communities reported that their coordination with the chemical facility includes joint participation in exercises. About a third of the communities reported that they had only initial contact or no contact with the facility in question.

From the facility perspective, the local fire departments, local emergency planning or civil defense offices, and local law enforcement agencies are the three major types of community organizations involved with chemical emergency alert and notification procedures. Facilities have varied levels of interaction with each of the three groups. The majority of the facilities that have participated in exercises with such groups reported having either one or two such events in the past two years. All of the facilities indicated that they had at least some coordination with local fire departments.

With respect to management practices, few communities have well-developed plans and procedures to guide emergency response. Notably lacking are capabilities to make decisions. Both lack of procedures and, more basically, knowledge about what information is needed to make a decision, suggest major problems with issuing a timely warning. Also lacking are pre-planned warning messages and public information programs.

7.4 RECOMMENDATIONS

As the SERCs and LEPCs established under Title III become more active, they should provide local forums for discussing the types of notification and alert problems identified by the study and go far toward solving them. By requiring industry to participate fully in the emergency planning process and to share information on the hazards of the chemicals present at their facilities, Title III promotes a dialogue that can identify where procedures and equipment are inadequate and strengthen the communication links between the facility and the local community.

The law specifically requires emergency plans that, among other things, designate facility and community emergency coordinators and lay out procedures for providing timely, reliable, and effective notification. These plans are to be tested with exercises and updated. It is important for the Federal government to continue to support and strengthen the capabilities of the SERCs and LEPCs by providing technical guidance and assistance in these areas.

The improvement of public alert systems is feasible without the development of new technologies. The problem of disseminating existing technology and knowledge is greater at present than the problems created by the lack of appropriate technology. Unless new technologies lead to low-cost equipment that can rapidly alert and notify the public and that can be easily installed and maintained, further technological advances would only increase the gap between practices and the available technologies.

At the local level the feasibility of improvement depends on two factors. The first is the dissemination of information on low-cost or no-cost improvements. Major improvements in management practices and procedures can be achieved without major expenditures. The second is the availability of funds for improved communication equipment and warning system equipment. It is unlikely that all communities have the funds to install new communication devices or new warning systems. Improvements in these areas will require assistance to the communities or cost sharing. Currently, improving management practices and developing better decision-making procedures within both the facilities and the communities appear more critical than improving technology. The most sophisticated equipment is relatively useless if it is not used properly.

The following recommendations are made:

- Standard operating procedures for initial response to alerts, warning decision-making, and protective-action recommendations should be developed at the local level. Computerized emergency planning and management systems and decision aids should be refined and adopted where appropriate.

- Local officials should have relevant chemical profiles at hand and a means to interpret the data, such as assistance from local AIChE chapters that have been established to assist emergency response programs.

- A standardized information protocol to guide the community in seeking appropriate information from the facility during the initial notification should be developed.

- Warning message protocols for both English-speaking, and where needed, non-English-speaking populations should be developed at the local level.

- The working relationships among personnel at the facilities and officials within the community emergency response structure should be improved. Communities should be encouraged to conduct frequent exercises.

- Public information programs should be strengthened; SERCs and LEPCs could participate in this effort.

- Notification and alert equipment must be maintained and tested regularly.

- Communications equipment within community emergency response organizations should be updated where feasible. Communication technologies between facilities and communities should be improved to include additional back-up capabilities.

- Public warning technologies in high-risk and densely populated areas should be improved. Communication links between communities and institutions such as hospitals should be improved.

- Studies of public response to warnings in chemical emergencies should be conducted to improve warning systems.

- Better information should be developed on sheltering versus evacuation as a protective action.

Appendix 1
Glossary of Terms/Acronyms

GLOSSARY OF TERMS

Accidental Release. An unexpected discharge or emission into the environment, possibly involving a fire or explosion, resulting from operational errors, improper maintenance, or equipment failure in the course of industrial activity.

Audit (Process Safety Audit). An inspection of a plant/process unit, drawings, procedures, emergency plan and/or management systems, etc., usually by an off-site team to assess plant safety.

Containment/Control. A system to which toxic emissions from safety release discharges are routed to be controlled.

Control System. A system designed to maintain automatically all controlled process variables within a prescribed range.

Dump Tanks. Standby, empty tanks for transfer of chemicals from a process/storage unit that may be leaking/ruptured or to relieve pressure.

Exothermic. A term used to characterize the evolution of heat. Specifically refers to chemical reactions from which heat is produced.

Extremely Hazardous Substances. Substances appearing on the list referred to in Section 302(a) of SARA and published in the Federal Register on November 17, 1986 (51 FR 41570, as revised on April 22, 1987, 52 FR 13378 and Feb. 25, 1988, 53 FR 5574). The list is composed of acutely toxic chemicals that might pose an acute or chronic hazard to a community upon release.

Facility. A location, with one or more structures, at which a process or set of processes produce, refine, use, or repackage chemicals, or a location where a large enough inventory of chemicals are used or stored so that a significant accidental release of a toxic chemical is possible.

Hazard. A characteristic of the chemical/system/plant/process that represents a potential for an accident.

Hazard Analysis Procedures: Techniques and procedures used to identify undesired events that lead to the realization of a hazard, the analysis of the mechanisms by which the undesired events could occur, and usually the estimation of the extent, magnitude, and likelihood of any harmful effects.

Hazard Evaluation Procedures: Qualitative and quantitative procedures for determining what failures or series of events could result in accidental releases of extremely hazardous substances and their probability of occurrence. These procedures should include hazard identification and hazard analysis procedures.

Hazard Identification Procedures: Qualitative techniques and procedures used to survey a plant or process to identify what equipment and procedure failures or series of events could result in an accidental release.

Monitoring and Detection Systems: (a) Technologies ranging from process instrumentation and in-plant detection devices to perimeter alert devices for anticipating emergency or upset conditions, identifying constituent chemicals in releases, providing data on the chemical composition of releases, and determining concentrations of chemicals in releases; and (b) Modeling technologies for determining the magnitude and direction of hazards posed by releases.

Perimeter Alert System: A system or array of detectors placed at the perimeter of a facility to detect releases of chemicals.

Post-Release Mitigation Systems. Systems and techniques applied to an extremely hazardous substance after the loss of containment has occurred, but while the substance is still within the plant boundaries, to reduce the possibility of off-site migration.

Pre-Release Prevention Systems. Systems and procedures designed to reduce the probability that the primary containment of an extremely hazardous substance will be breached.

Pre-Release Protection Systems. Specific pre-release control techniques that either contain, destroy, or reduce the quantity of the substance prior to its release to the environment.

Prevention Systems. Any technology or management practice that aids in preventing accidental releases. Prevention systems include pre-release prevention systems, pre-release protection systems, post-release mitigation systems, as well as hazard evaluation techniques.

Primary Containment. The containment provided by the piping, vessels, and machinery used in a facility for handling chemicals under normal operating conditions.

Probability. An expression of the likelihood of an event or event sequence occurring.

Process. The sequence of physical and chemical operations for the production, refining, repackaging, or storage of chemicals.

Process Machinery. Process equipment, such as pumps, compressors, heaters, or agitators, that would not be categorized as piping and vessels.

Public Alert Systems. Equipment, technologies, and procedures for providing timely and effective public warning of an accidental release as well as for informing the public of precautionary measures.

Qualitative Evaluation. An assessment of the risk of an accidental release in relative terms, the result of the assessment being a verbal description of the risk.

Quantitative Evaluation. An assessment of the risk of an accidental release in numerical terms, the end result being a number that reflects risk, such as faults per year.

Reactivity. The ability of one chemical to undergo a chemical reaction with another chemical. Reactivity of one chemical is always measured in reference to the potential for reaction with itself or with another chemical.

Real-Time. The actual time during which an emergency or event is occurring.

Redundancy. For control systems, redundancy is the presence of a second piece of control equipment where only one would be required. The second piece of equipment is installed to act as a backup in the event that the primary piece of equipment fails.

Review (Process Safety Review). An inspection, for the purpose of assessing safety, of a plant/process unit, drawings, procedures, emergency plans, and management systems, usually by an on-site team and usually problem-solving in nature.

Risk. A measure of potential economic loss or human injury in terms of the probability of the loss or injury occurring and the magnitude of the loss or injury if it occurs.

Routine Release: A process emission, such as atmospheric venting, designed into a process of operation to maintain operational control.

Secondary Containment. Process equipment specifically designed to contain material that has breached primary containment before the material is released to the environment and becomes an accidental release.

Shortstops. A chemical that when added to chemical reactants will stop any further reactions.

ACRONYMS

AIChE -- American Institute of Chemical Engineers.

ARIP -- Accidental Release Information Program.

CAER -- Community Awareness and Emergency Response Program.

DOE -- U.S. Department of Energy.

DOT -- U.S. Department of Transportation.

EBS -- Emergency Broadcast System.

EOC -- Emergency Operations Center

EPA -- U.S. Environmental Protection Agency.

FEMA -- Federal Emergency Management Agency.

LEPC -- Local Emergency Planning Committees.

OSHA -- Occupational Safety and Health Administration.

PRA -- Probabilistic Risk Assessment.

SARA -- Superfund Amendment and Reauthorization Act of 1986.

SERC -- State Emergency Response Commission.

TPQ -- Threshold Planning Quantity.

Appendix 2
Survey Responses

SURVEY RESPONSES

Facility Survey

As of February 16, 1988, 146 of the 522 facilities sent surveys had returned completed questionnaires; because one facility returned two questionnaires, for different chemicals, the number of completed questionnaires is 147. Two facilities returned incomplete questionnaires; four other facilities returned completed questionnaires marked as confidential business information. No information from these six questionnaires is included in the data base.

Of the 372 questionnaires that were not completed, 72 facilities did not complete the questionnaire because they no longer use the chemicals being considered or use them in quantities below the threshold planning quantity (TPQ). Another 55 facilities, while they were listed in the data bases, had either gone out of business or EPA was unable to contact them by mail or by follow-up calls.

Exhibit A 2-1 provides a breakdown of the facilities surveyed by chemical, and the response rate. The responses are concentrated in a relatively small number of the chemicals, which is partly a function of the normal density of facilities throughout the U.S. using the various chemicals.

The respondents included large chemical manufacturers, small chemical manufacturers, refineries, food manufacturers, chemical distributors, batch process plants, and water treatment plants. The smallest plant that responded had six full-time employees. Exhibit A 2-2 is a summary of responses by facility size (number of employees).

As can be seen from Exhibit A 2-3, the responding facilities are concentrated in the Atlantic Coast, Great Lakes, and Gulf Coast regions, with comparatively few facilities in New England and the Midwestern and Western regions of the U.S. This distribution is, in part, a function of the normal density of industrial facilities in the various regions.

Exhibits A 2-4 and A 2-5 summarize the distribution with respect to age of the facilities, with both the date of the construction and the date of the latest modification. Although the majority of respondents were older facilities, most indicated recent modifications.

EXHIBIT A 2-1

SURVEY RESPONSES BY CHEMICAL

	Number of Facilities			
Chemical Name	Requested to Complete Questionnaire	Could Not Be Contacted	Were Not Eligible	Number of Completed Questionnaires
Acrylonitrile	23	1	5	7
Ammonia	86	12	2	25
Benzenearsonic Acid	3	0	1	0
Benzotrichloride	4	0	1	2
Chlorine	94	2	4	38
Chloroacetic Acid	34	7	7	7
Furan	5	0	0	1
Hydrazine	9	0	1	4
Hydrogen Cyanide	15	3	2	3
Hydrogen Fluoride	36	5	6	7
Hydrogen Sulfide	56	6	7	20
Mechlorethamine	2	0	2	0
Methiocarb	12	0	5	1
Methyl Bromide	18	3	4	6
Methyl Isocyanate	6	1	1	2
Phosgene	19	2	2	6
Sodium Azide	20	3	6	1
Sulfur Dioxide	52	7	7	13
Sulfur Trioxide	17	2	4	4
Tetraethyl Tin	3	0	0	0
Trichloroacetyl Chloride	8	1	5	0
Totals	522	55	72	147*

* One facility completed two questionnaires, one for chlorine, one for ammonia.

Exhibit A 2-2

Survey Responses by Facility Size

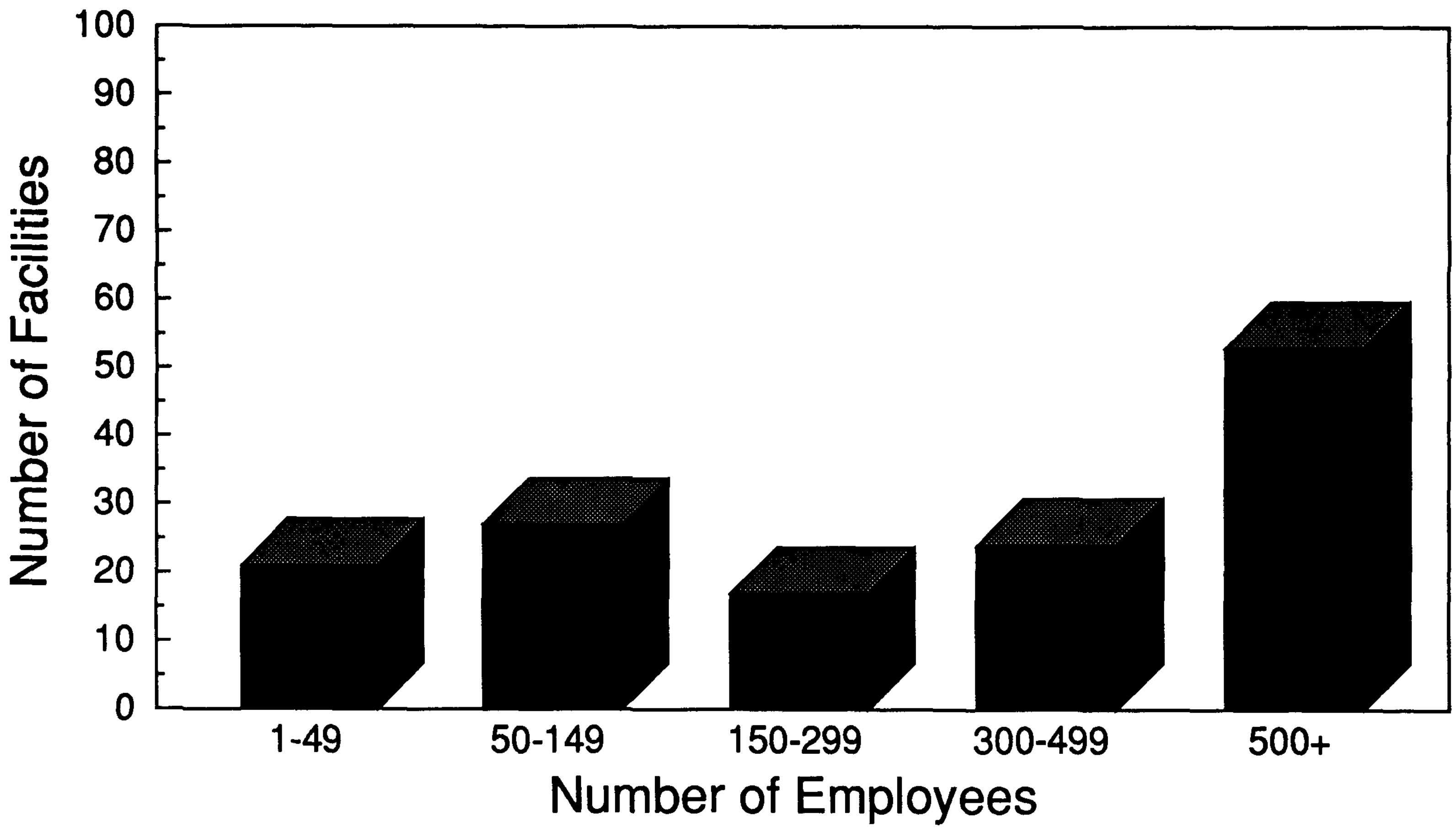

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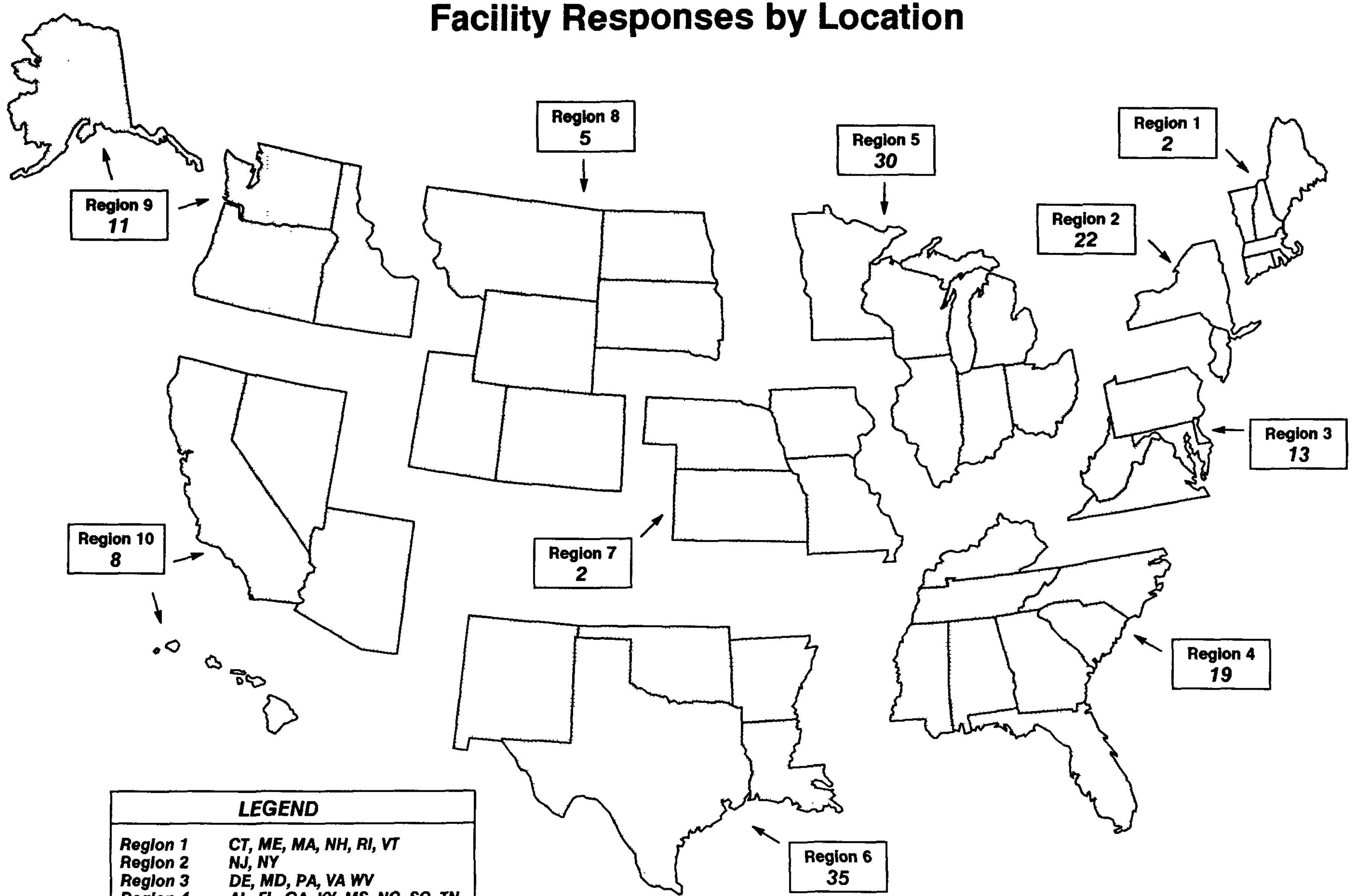
Exhibit A 2-3

Facility Responses by Location



LEGEND	
Region 1	CT, ME, MA, NH, RI, VT
Region 2	NJ, NY
Region 3	DE, MD, PA, VA WV
Region 4	AL, FL, GA, KY, MS, NC, SC, TN
Region 5	IL, IN, MI, MN, OH, WI
Region 6	AR, LA, NM, OK, TX
Region 7	IA, KS, MO, NE
Region 8	CO, MT, ND, SD, UT, WY
Region 9	AZ, CA, HI, NV
Region 10	AK, ID, OR, WA

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Exhibit A 2-4

Date of Construction of Process System

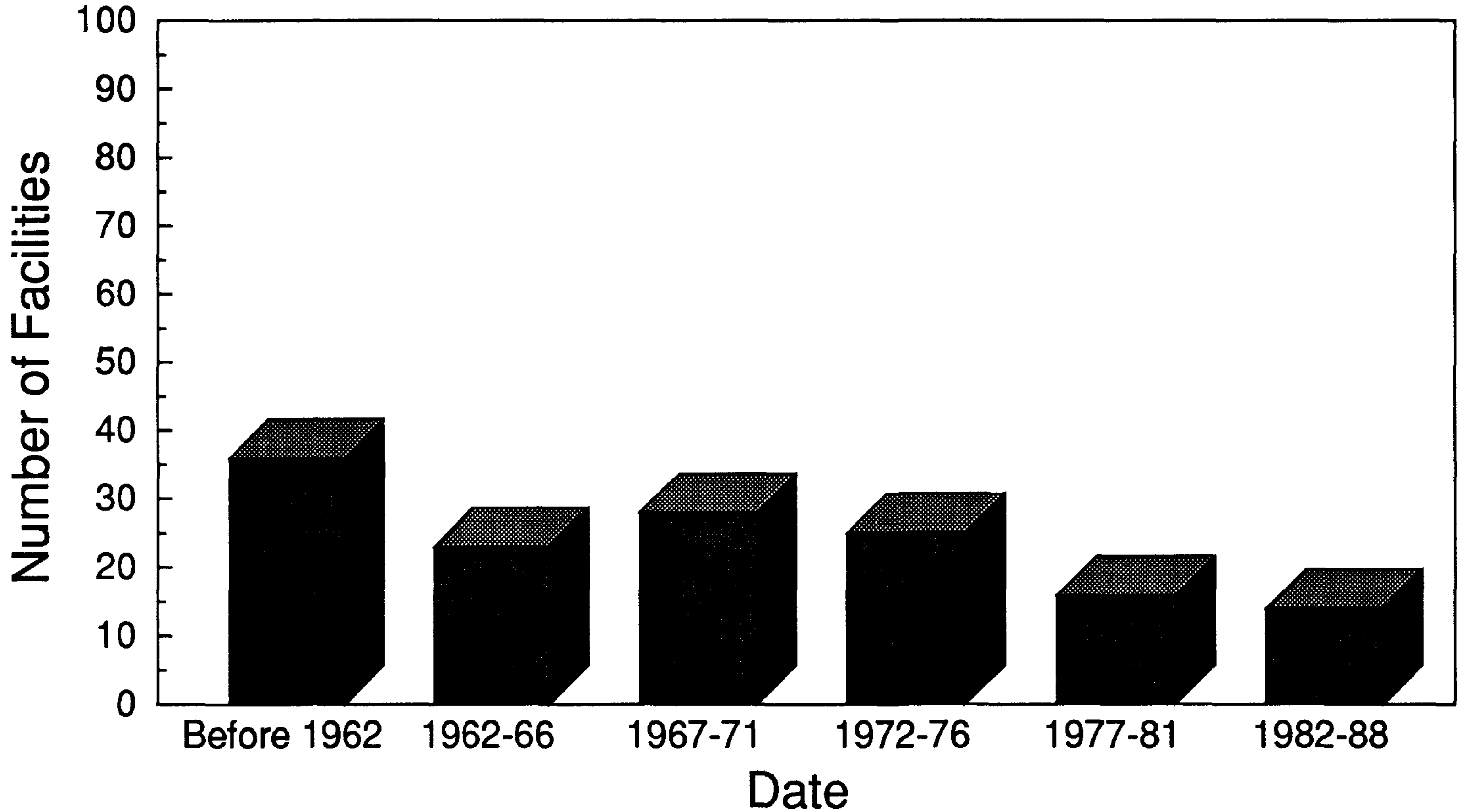

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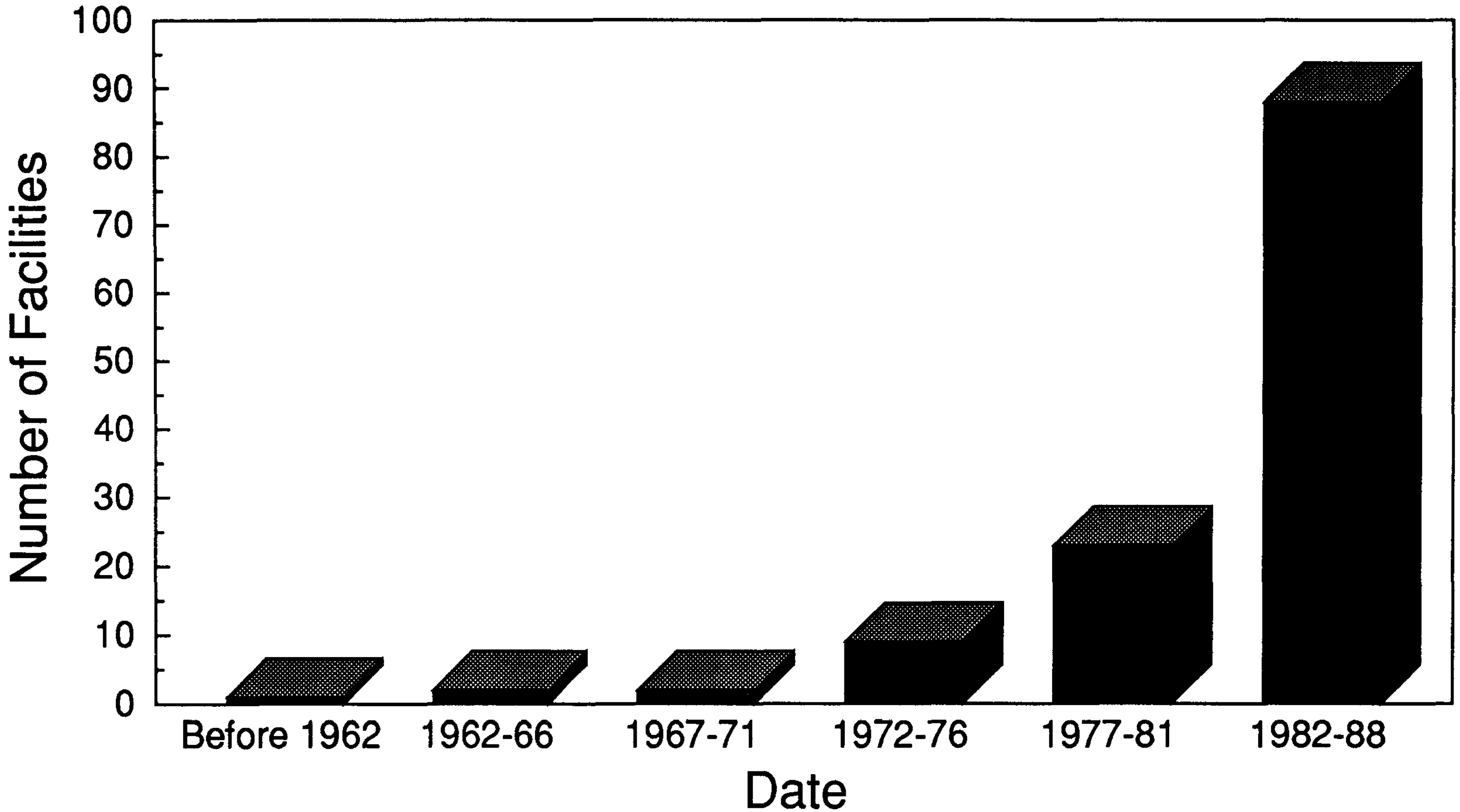
Exhibit A 2-5

Date of Major Upgrade of Process System



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Community Survey

FEMA sent 277 questionnaires to communities identified as having jurisdiction over one or more of the facilities selected for the facility survey. Of these, 142 communities returned completed questionnaires. Twenty-three returned the survey because the facility in question no longer was covered by the jurisdiction or no longer existed. Of the communities that responded, about 40 were adjacent to one of the 152 facilities that returned the facility survey. Exhibit A 2-6 shows the facility response by geographic location.

The number of households in an area, the population distribution, and the population density are relevant aspects of the warning problem. The chemical facilities selected for the survey are located in fairly densely populated areas. An average of about 4,400 people reside within a 1 mile radius of the facilities. In one case, 35,000 people are estimated to live within 1 mile. On average, the population density is about 1,370 people per square mile assuming a uniform distribution, but because about 30 percent of the area within 1 mile of the facilities is in residential use, the areas that are populated actually have a greater density. Within 5 miles of the facilities, the average population is 42,600 with an average density of 550 people per square mile. The maximum population within 5 miles of a facility is estimated at 600,000. In several cases, however, the population within 5 miles is close to zero. Overall, however, the population density within 1 mile of the plant is much greater than within 5 miles. Exhibit A 6-7 gives the distribution of community responses by size of the community.

Another important characteristic is population fluctuations. These can occur on a diurnal cycle; for example, a large number of commuters may be present during the day, but not at night. Conversely, suburban areas may have their peak populations at night. Weekly fluctuations may occur on certain days as in the case of a recreation area which is crowded on weekends. Finally, seasonal variation can be significant. Diurnal population fluctuations are reported at roughly one-half of the sites. Weekly population fluctuations are more uncommon, occurring in 29 percent of the communities surveyed. Seasonal population fluctuations are reported in only 15 percent of the communities.

A third important population characteristic involves special population subgroups. Institutional populations include people in schools, hospitals, correctional facilities, nursing homes and other facilities in which people cannot fully care for themselves. They require special warning considerations because they require assistance and, hence, a longer time to respond to an emergency. About 83 percent of the communities have institutionalized populations within 5 miles of the facilities. Several have facilities in numbers sufficiently large that respondents would report that there are many or numerous but not report the actual number, while others may have only a few. Schools are the most common facility (64 percent of the communities) reported, followed by hospitals and nursing homes (41 and 45 percent, respectively). Twenty-five percent of the communities report having prisons or jails. All such institutional facilities require special and rapid warning consideration in order to give them the extra time needed to respond.

Exhibit A 2-6

Community Responses by Location

LEGEND

Region 1	*CT, ME, MA, NH, RI, VT*
Region 2	*NJ, NY*
Region 3	*DE, MD, PA, VA WV*
Region 4	*AL, FL, GA, KY, MS, NC, SC, TN*
Region 5	*IL, IN, MI, MN, OH, WI*
Region 6	*AR, LA, NM, OK, TX*
Region 7	*IA, KS, MO, NE*
Region 8	*CO, MT, ND, SD, UT, WY*
Region 9	*AZ, CA, HI, NV*
Region 10	*AK, ID, OR, WA*

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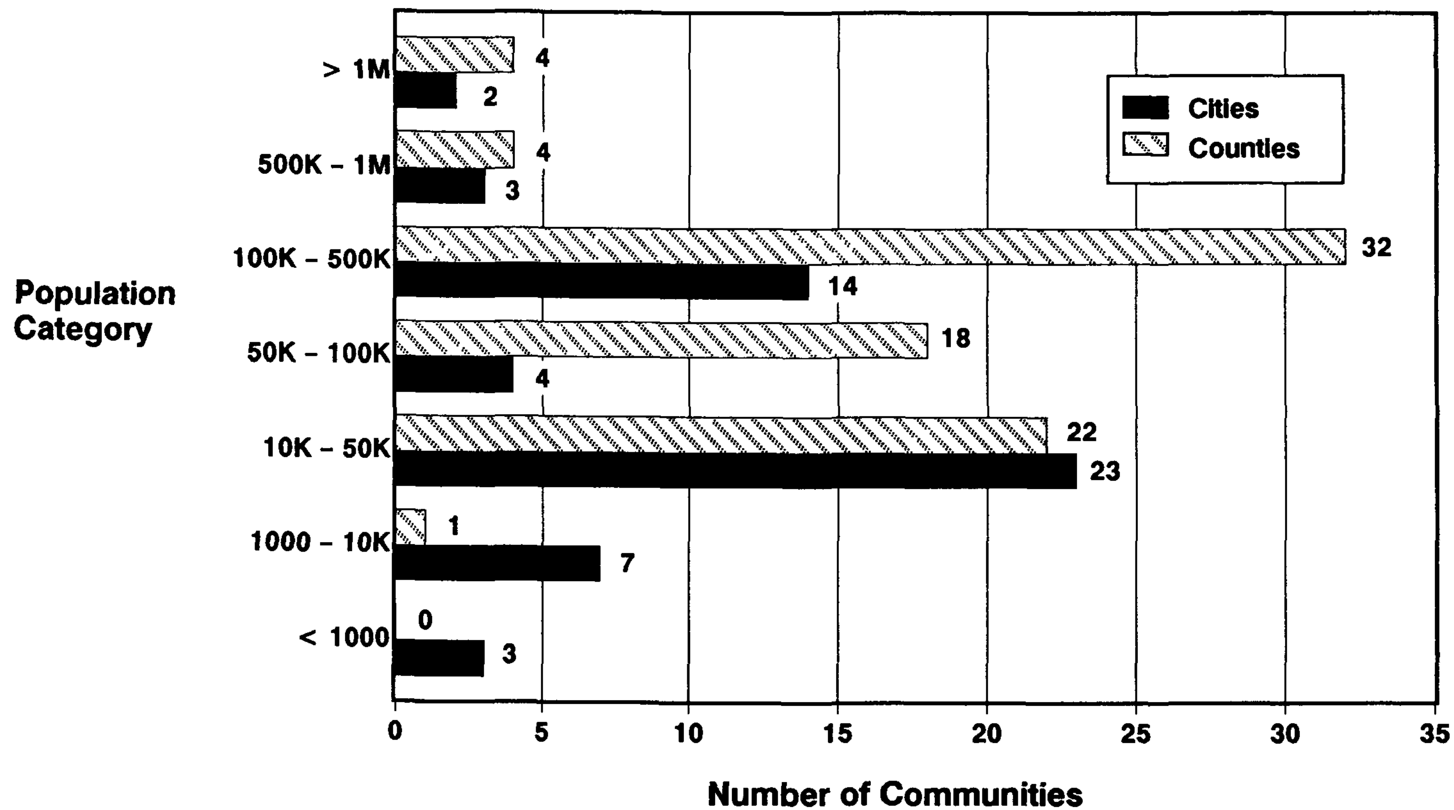
Exhibit A 2–7

Distribution of Sample Communities



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Appendix 3
Hazard Evaluation Procedures

AIChE HAZARD EVALUATION PROCEDURES

Process/system checklists contain information concerning specific items in process design, construction, and operation and provide a means for standardized evaluation of plant hazards. They are a convenient means of communicating the minimally acceptable level of hazard evaluation that is required for any job.

Safety review is also referred to as a Process Safety Review, a Loss Prevention Review, or a Process Review. It is intended to identify plant conditions or operating procedures that could lead to an accident. A safety review involves inspections of plant equipment and procedures by a team of specialists.

Dow and Mond Index provides a method for relative ranking of the risks in a chemical process plant. The method assigns penalties to process materials and conditions that can contribute to an accident. Credits are assigned to plant safety procedures that can mitigate the effects of an accident.

Preliminary Hazard Analysis is intended for use only in the preliminary phase of plant development for cases where past experience provides little or no insight into potential safety problems. The analysis focuses on the hazardous substances and on major plant elements.

What If Analysis is used to consider carefully the result of unexpected events that would produce adverse consequences. The method involves the examination of possible deviations from intended design, construction, modification, or operating procedures of a process. It requires a basic understanding of what is intended and the ability to combine or synthesize possible deviations that would cause an undesired result.

Hazard and Operability Studies are conducted by teams that brainstorm to identify hazards and operability problems by searching for deviations from design intents. The team considers the causes and consequences of a deviation.

Failure Modes, Effects, and Criticality Analysis is a tabulation of the system/plant equipment, their failure modes, each failure mode's effect on the system/plant, and a criticality ranking for each failure mode. The failure mode is a description of how equipment fails.

Fault Tree Analysis is a deductive technique that focuses on one particular accident event and provides a method for determining causes of the event. The fault tree is a graphic model that displays the various combinations of equipment faults and failures that can result in the accident event.

Event Tree Analysis considers operator response or safety system response to an initiating event in determining accident outcome. The results are accident sequences.

Cause-Consequence Analysis is a blend of fault tree and event tree analysis. The cause-consequence diagram displays the interrelationships between accident outcomes and their basic causes.

Human Error Analysis is a systematic evaluation of the factors that influence the performance of human operators, maintenance staff, technicians, and other personnel. It will identify error-likely situations that can cause an accident.

EXHIBIT A 3-1

NUMBER OF FACILITIES USING AIChE-RECOGNIZED HAZARD ASSESSMENT TECHNIQUES

Techniques	Facilities*
"What If" Analysis	42
Hazard and Operability Studies	36
Fault Tree Analysis	14
Failure Modes, Effects, and Criticality Analysis	8
Preliminary Hazard Analysis	8
Event Tree Analysis	4
Human Error Analysis	1
Dow and Mond Hazard Indices	1
Cause-Consequence Analysis	1

* Many facilities listed more than one method. A total of 73 of the 146 facilities listed at least one AIChE-recognized method.

Appendix 4
Survey Responses on Prevention

EXHIBIT A 4-1

FACILITIES CITING SCRUBBERS

Chemical	Facilities Responding	Facilities Citing Scrubbers
Ammonia	25	5
Chlorine	37	18
Hydrogen Cyanide	3	2
Hydrogen Fluoride	7	3
Hydrogen Sulfide	21	7
Sulfur Dioxide	13	10

EXHIBIT A 4-2

METHODS OF DETECTING DISABLED CONTROL DEVICES

Method of Detection	Number of Facilities Citing
Monitors	40
Routine Inspection	45
Operator Observation	42
Alarms	36
Routine Testing	15

EXHIBIT A 4-3

SPECIFIC MONITORS REPORTED FOR RELEASE DETECTION

Monitors	Number of Facilities Citing
In-Stack	18
Ambient Air	52
Sewers	12
Surface/waste water	33
Ground Water	4

Appendix 5
Prevention and Protection Measures

APPENDIX 5

This appendix consists of two exhibits. Exhibit A 5-1 identifies general prevention/protection measures for a broad range of hazards associated with a variety of hazardous chemicals. Exhibit A 5-2 identifies additional measures that apply specifically to the 21 chemicals used as a focus for this review. The measures identified are general in scope and not intended to be all inclusive. The appropriateness of any measure is facility- and process-specific.

EXHIBIT A 5-1

EXAMPLES OF PREVENTION/PROTECTION MEASURES THAT APPLY TO MANY HAZARDOUS CHEMICALS

Hazard Area	Prevention/Protection Measures
Fire/explosion	Isolate equipment from ignition or fire sources and flammable materials; inert gas padding to prevent air/oxygen to prevent air/oxygen or water levels; explosion-proof electrical equipment; proper grounding for static discharges; protect wire and cable feed for critical controls from fire damage; fireproof control valves; heat shielding of critical equipment and structure; automatic sprinkler systems, deluge nozzles, foam application; non-sparking tools and equipment; temperature controls, interlocks, alarms; "fail-safe" (e.g., a valve closes to shut off flow when power is lost) controllers and equipment; explosive gas, heat, flame monitors, and alarms; periodic drills, testing,inspection of fire equipment; written fire response procedures; vent flame arresters, conservation vent; blast doors.
Equipment failure: general, vessel storage, intermediate tanks and lines	Ensure proper design; materials on construction; equipment hydrostatic and pressure testing and inspection procedures; leak checks; preventive maintenance; corrosion, erosion monitoring; proper installation; design for vibration, thermal expansion; secondary containment; berms; diking; emergency drain pumps, foam injection.
Pipes and valves	In addition to general items: excess flow valves, flange and valve seal guards; double piping; non-flanged, non-threaded (all welded) pipe; valve testing.
Seals and fusible plugs	In addition to general items: purge pump seals to prevent escape of material; use double mechanical seals; test and inspect fusible plugs; install containment around fusible plugged equipment.

Hazard Area	Prevention/Protection Measures
Overpressure	In addition to general items: proper relief vent design; vents free from restrictions; system operating procedures; alarms and interlocks for pressure and level; redundant controls; vent relieved vapors to scrubbers/flares to prevent release to atmosphere.
Pumps, critical mechanical equipment	In addition to general items: standby backup equipment; regular testing to ensure operability of backup equipment; additional preventive maintenance for critical devices.
Process changes	Hazard analysis prior to change; written "experimental operating conditions" procedures that document non-standard operation until changes are complete and standard; increased inspection and diligence during changeover.
Loss of heating/ cooling, flow, inerting, power, air, mixing	Temperature, pressure, flow monitors; alarms; interlocks; backup pumps, generators, instrument air cylinders, heating, cooling systems; fail-safe equipment; monitor cooling water for process contaminants; non-mechanical spargers to maintain mixing.
Overfilling	Vessel level monitors, alarms, interlocks; diking, secondary containment; operating procedures; neutralization of spills; use of absorbent materials, foams.
Contamination, runaway reaction	Contaminant monitoring, alarms, interlocks; quenching systems; reactor dumping vessels; deluge systems; specific operating parameters, controls; standard operating conditions; isolation of possible contamination sources (blanking); backflow prevention (checkvalves).
Human error	Training and retraining; testing; job safety audits; job performance checks; standard job procedures; checklists; corrective actions; redundant backups (e.g., "dead-man" switch); training on process simulators; safety policies, programs, procedures.

Hazard Area	Prevention/Protection Measures
External impacts: lightning, flood, tornado, earthquake, collision with vehicles or other equipment	Isolate pipes, vessels, etc. from high traffic areas; install barricades; install proper grounds and lightning rods; emergency shutdown procedures during dangerous situations; flood walls and drains for high water; earthquake-designed equipment footing; wind protection.

Note: Use of any of these measures should result from detailed hazards analyses of specific operations. A variety of prevention measures may be used to establish an overall prevention strategy for a specific operation.

EXHIBIT A 5 - 2

EXAMPLES OF SPECIFIC PREVENTION/PROTECTION MEASURES FOR THE 21 CHEMICALS

Chemical	Problem Area	Comments
Ammonia	Atmospheric releases from processes, relief discharges.	Emergency vent scrubbing to remove ammonia.
	Liquid choked vapor lines; overpressurization.	Ensure proper heating for vaporization control; temperature monitoring with interlocks and shutdowns; excess flow control with restricted orifices.
	Corrosive to copper and galvanized surfaces.	Ensure proper materials of construction; monitor corrosion.
	Reactivity	Mixing several chemicals can cause severe fire hazards and explosions. Ammonia in container exposed to heat of fire may explode. Avoid contamination with backflow prevention, isolation; cool fire exposed containers.
Chlorine	Extremely corrosive in presence of water.	Moisture monitoring; ensure proper materials of construction; corrosion monitoring; startup and maintenance procedures to ensure dry conditions; pad gas dryers and monitors; prevent backflow.
	Reactivity	Reacts vigorously with most metals at high temperature; control temperature, materials of construction, avoid copper and aluminum for high temperature applications or potential; incompatible with plastics and rubber; mixture with fuels may cause explosion; hydrogen and chlorine mixtures are exploded by almost any form of energy; avoid contact with fuels and hydrogen.
	Liquid choked vapor lines; overpressurization.	Ensure proper materials of construction; monitor corrosion.
	Atmospheric releases from processes, relief discharges.	Emergency vent scrubbing to remove chlorine.

Chemical	Problem Area	Comments
Hydrogen cyanide	Runaway reactions from excess HCN	Redundant flow control; flow limits by line or orifice size; flow interlocks; concentration monitoring and interlock.
	Atmospheric release from processes, relief discharges	Emergency vent scrubbing to remove HCN.
	Fire hazards	Vapor may explode if ignited in a confined area, may become unstable and subject to explosion it stored for extended time or exposed to high temperature and pressure; see general fire hazard precautions. Unstabilized material may polymerize spontaneously with explosive violence, explosion potential severe when exposed to heat or oxidizers, may form explosive mixtures with air; ensure isolation from oxidizers, maintain storage stability; keep containers cool in fire situations; use nitrogen padding for vessels.
Hydrogen fluoride	Water contamination	Prevent backflow; continuous moisture monitoring; corrective action procedures for wet feedstocks.
	Atmospheric release from processes, relief discharges	Emergency vent scrubbing to remove HF.
	Reactivity	Will attack glass, concrete, and certain metals, e.g. those containing silica; attacks natural rubber, leather, many organic materials; may generate flammable H_2 gas in contact with some metals; watch material of construction; monitor for H2. When heated, highly corrosive fumes emitted, corrosive actions on metals may generate H_2; keep vessels cool if exposed to heat or flame.

Chemical	Problem Area	Comments
Hydrogen sulfide	Smell sensitization	If odor used to detect leaks, consider monitoring equipment; workers may become desensitized to odor.
	Fire/explosion	Avoid ignition sources in contained areas. Forms explosive mixtures with air over a wide range; reacts explosively with several halogenated organics, inorganics; avoid contact with these and eliminate air in process systems; use nitrogen padding.
Methyl isocyanate	Reactivity	Highly reactive in water, acid, alkali, amine, iron, tin, copper, thier salts, other catalysts; watch material of construction, moisture, contaminants.
	Polymerization	May exothermically autopolymerize; heat produced raised pressure; may rupture containers; continually sample containers, monitor quality. Control temperature, install redundant controls, alarms, backups.
Phosgene	Reactivity	Decomposes with water (not vigorously); control moisture content; use padding to prevent moist air inlets. Reacts violently with aluminum, isopropyl alcohol, other organics; ensure proper materials of construction, avoid contamination, backflow; isolate phosgene processing streams.
	Atmospheric release from processes, relief discharges	Emergency vent scrubbing to remove phosgene.
Sulfur dioxide	Reactivity	Explosive with several chemicals, incompatible with aluminum and some metals. Reacts with water to form toxic and corrosive fumes; avoid contact with incompatibilities; ensure materials of construction; maintain dry process systems.
	Atmospheric release from processes, relief discharges	Emergency vent scrubbing to remove SO_2.

Chemical	Problem Area	Comments
Sulfur trioxide	**Reactivity**	Combines with water explosively to form sulfuric acid; may ignite combustible materials; explosive increase in vapor pressure when alpha form melts, flammable poisonous gases may form in tanks and hopper cars; on exposure to air, absorbs moisture, forms dense white fumes. Avoid contact with moisture; keep containers cool to control melting; use redundant controls; control ignition sources around tank vents; use proper vent system to control vapor concentrations.
Acrylonitrile	Reactivity/Explosion	Attacks copper and, in high concentrations, aluminum. Avoid contact with strong acids, amines, alkalis, strong oxidizers, copper and copper alloys, aluminum. Ensure proper materials of construction; ensure replacement equipment contains no copper.
	Self-polymerization in presence of alkali, heat, light, lack of oxygen	Avoid exposure to light, strong bases; ensure proper temperature monitoring and control, with backup; frequent sampling and corrective action procedures; inhibitor addition and control; air padding.
Benzenearsonic acid	Heating/Decomposition	Emits poisonous fumes of arsenic when heated to decomposition; ensure proper temperature control with backups; sample for material integrity; keep vessels cool in fire and heating situations.
Benzotrichloride	Reactivity	May react violently with water; hydrolysis in water forms corrosive benzoic and hydrochloric acids; fire may produce irritating or poisonous gases; flammable/poisonous gases may accumulate in tanks and hopper cars; materials may ignite combustibles; Monitor for moisture; watch materials of construction; corrosion control; control ignition sources around tank vents; use proper vent system to control vapor concentrations; use dry chemical or foam for fires; keep containers cool.

Chemical	Problem Area	Comments
Chloroacetic acid	Equipment pluggage	Flow sensors with alarms; protection pumps to prevent overheating or overpressure in loss of flow; steam or electric trace lines to keep material molten.
	Heating/fire	When heated to decomposition, emits highly toxic chlorine and phosgene. Water may cause frothing if it gets below surface and turns to steam; Flammable/poisonous gases may accumulate in tanks and hopper cars; some gases may ignite combustibles; use redundant cooling to ensure temperature control; apply water fog gently to make foam to extinguish fire.
Furan	Reactivity	Very dangerous when exposed to heat or flame; may form unstable peroxides on exposure to air; contact with acids can start a violent reaction; avoid contact with strong acids and oxidizing agents; use redundant temperature sensors; proper mixing and backup; redundant cooling systems; use nitrogen pad storage vessels; ensure air free system.
Hydrazine	Thermal decomposition or exothermic reaction.	Avoid contact with copper, cobalt, molybdenum, and iron oxides (rust); redundant temperature and cooling control, inert gas system to prevent reactions with oxygen and spontaneous ignition; prevent contact with sodium or calcium hypochlorite.
	Reactivity	Can catch fire when in contact with porous materials such as wood, asbestos, cloth, earth, and rusty materials; maintain containment, avoid contact with these materials.
Mechlorethamine	Reactivity	Undiluted liquid decomposes upon standing; ensure proper mixing, use dilute forms, sample and monitor material integrity.

Chemical	Problem Area	Comments
Methiocarb	Fire/explosion	Dust may be explosive; avoid dusty conditions and potential ignition sources.
Methyl bromide	Heating	When heated to decomposition, emits highly toxic fumes. Use redundant temperature control and monitoring to ensure heating to less than decomposition.
Sodium azide	Reactivity/Stability	Stable unless in contact with acid; avoid contact with acid solutions; forms explosion-sensitive materials with some metals such as lead, silver, mercury, copper. Check material of construction.
Tetraethyltin	Reactivity	Avoid contact with strong oxidizers; upon decomposition, emits acrid smoke and fumes; isolate process from strong oxidizers, control heat, use backup cooling and temperature control.
Trichloroacetyl chloride	Reactivity	May react violently with water. Avoid water entry into process streams use foam, dry chemical, for fire control.

Appendix 6
Monitoring and Detection

COST ESTIMATES FOR PERIMETER MONITORING SYSTEMS

Perimeter monitoring systems were defined for the purposes of cost estimation as integrated detector networks in place at a facility fenceline to provide continuous, real-time measurement of releases of specific chemicals from the facility. Industry representatives and equipment vendors indicated that chemical detectors or monitoring stations for systems in use are placed between 250 and 1,000 feet apart along the facility perimeter, depending on the local topography, local meteorology, distribution of potential release sources and receptors, and other factors. For the purposes of cost estimation, it was assumed that detectors are placed 500 feet apart along the facility perimeter.

Equipment, installation, and operating/maintenance costs were estimated for three types of commercially available chemical detectors: fluorescent sulfur dioxide analyzers, photo-electric tape sensors, and electrolytic chlorine detectors. Photo-electric tape sensors can be used to detect chlorine, phosgene, hydrogen sulfide, and ammonia. Cost estimates are based on information obtained from the Section 305(b) questionnaires and site visits, as well as follow-up contacts with industry representatives and equipment vendors. The estimates were prepared for small and large facilities. A large facility is assumed to have an area of 640 acres (one square mile) and approximately 21,000 feet of linear perimeter, requiring a total of 42 monitoring stations. A small facility is assumed to have an area of 30 acres and approximately 5,000 feet of linear perimeter, requiring a total of 10 monitoring stations.

The annualized costs of the perimeter monitoring systems were calculated by discounting the total equipment and installation cost of the systems using a discount rate of 5 percent and adding the annual operating and maintenance cost. A system operating life of 10 years was assumed, and no economies of scale were assumed for systems with large numbers of detectors. A salary plus overhead rate of $50,000 per year was assumed for a technician to operate and maintain the monitoring system.

[Note: The comments in this appendix should not be interpreted to imply endorsement of any specific detection device or model by EPA.]

EXHIBIT A 6-1

NUMBER OF PROCESS AREA AND PERIMETER MONITORING SYSTEMS REPORTED

Chemical Name	Number of Completed Questionnaires	Process Area Monitors	Perimeter Monitors
Acrylonitrile	7	5	0
Ammonia	25	4	0
Benzenearsonic acid	0	0	0
Benzotrichloride	2	0	0
Chlorine*	38	19	3
Chloroacetic acid	7	0	0
Furan	1	0	0
Hydrocyanic acid	4	3	0
Hydrazine	3	0	0
Hydrogen fluoride	7	0	0
Hydrogen sulfide	20	13	2
Mechlorethamine	0	0	0
Methiocarb	1	0	0
Methyl bromide	6	0	0
Methyl isocyanate	2	1	0
Phosgene	6	5	0
Sodium azide	1	0	0
Sulfur dioxide**	13	3	3
Sulfur trioxide	4	1	0
Tetraethyltin	0	0	0
Trichloroacetyl Chloride	0	0	0
Total Reported	147	54	8

* One facility reporting ammonia also provided information on their process area and perimeter chlorine monitoring systems.

** Several facilities reporting sulfur dioxide had from one to four sulfur dioxide monitors located off-site in the surrounding communities. These

EXHIBIT A 6-2

MAJOR METHODS USED BY GAS ANALYZERS

METHOD	DESCRIPTION
Colorimetric	Reaction between toxic gas and chemically sensitive solution or coating causes measurable color change.
Electrochemical	Chemical or physical properties of toxic gas changes the electrical parameters of an input sensor. Electrochemical measurements include conductivity, potentiometric, and coulometric.
Spectrometric	Light beam is altered by contaminant gases. Spectrometric methods include infrared, Raman, microwave, and laser-induced detection atmospheric radiation (LIDAR).
Chromatographic	Instrument separates and measures gas concentration using various detectors including thermal conductivity, flame ionization, flame photometric (H_2S, SO2) nitrogen-phosphorus, electron capture (Cl_2, HF), and photoionization.
Indicator tubes	Toxic gas pumped through the detector tube produces a stain length proportional to the toxic gas concentration.

EXHIBIT A 6-3

EXAMPLES OF DETECTION DEVICES

Instrument	Description	Gases	Benefits/Capability	Limitations
Photovac 10S50 (Foxboro Corp.)	Automated gas chromatograph with photoionization detector; direct gas sampling.	Low volatile organics and inorganics such as phosphine, arsine, ammonia, nitric oxide, benzene, hydrogen sulfide.	Self-contained, portable unit; ppb for hydrogen sulfide, benzene.	Short term puff can saturate; sensitive to weather changes; requires experienced analyst to operate and interpret data.
Model PI 101 Hazardous Waste Detector (HNU System Inc.)	Automated gas chromatograph with photoionization and electron capture detectors; direct gas sampling.	Organic and inorganic vapors.	Battery operated and portable. 0.1-2000 ppm detection range; accuracy within 4 percent at 5ppm.	Not gas-specific; weather sensitive; experienced analyst required; short puff can saturate; frequent calibration required.
Model 128 Century Organic Vapor Analyzer (Foxboro Corp.)	Either in total organic or gas chromatograph mode (flame ionization detector).	Non-methane compounds in total organic mode; separates most organic components in GC mode.	0.2 ppm detection limit.	Not gas specific for organics; calibration required; experienced analyst needed; must be within inches of source in total organic mode; saturated by short puff.
Detector Tubes (Draeger)	Chemical stains the chemical sensitive substance in tube.	Chlorine, hydrogen chloride, hydrogen cyanide, hydrogen sulfide, methyl bromide, methylene chloride, sulfur dioxide, etc.	Easy to use; rapid results; inexpensive.	Each tube identifies only one gas; operator must know which gas has been released; subject to interference; low accuracy.
Combustible Gas Indicator	Caloric potential; measures increased heat on platinum filament.	Combustible gases.	Self-contained, battery operated.	Filament damaged by silicons, halides, tetraethyl lead; invalid readings under oxygen deficient conditions; must be calibrated before use.
MIRAN IBX Infrared Spectrophotometer (Foxboro Corp.)	Air analyzer using a single beam spectrophotometer; infrared spectrometric.	Over 100 gases.	Self-contained, battery operated; designed to quantify 1 or 2 components; 0-100 ppm.	Expensive. Subject to interference by water vapor and CO_2; requires experienced operator.

Instrument	Description	Gases	Benefits/Capability	Limitations
555 Continuous Color Analyzer (CEA)	Colorimetric; reagent solutions change color in presence of gases.	Cl_2, HCl, NH_3, SO_2, HCN, et al.	0-100 ppm for most gases; a-100 ppb for HCN; self-contained, battery operated, portable; accuracy within 1 percent.	Each gas requires modification to system; requires skilled operator; subject to interference.
HS-7 Unit SC-7 Unit (GasTech)	Electrochemical sensor.	H_2S, NO_2, SO_2, Cl_2, HCl.	Calibrated only once a year; less susceptible to corrosion and contamination; continuous or intermittent measurements; self-diagnostic capability; 0-100 ppm range; accuracy within 3 percent.	Subject to interference; each gas requires separate unit.

PPM -- parts per million
PPB -- parts per billion

EXHIBIT A 6-4

AIR DISPERSION MODELS CITED BY FACILITY RESPONDENTS

System/Model Name	Capability	Description/Requirements	Cost Estimate	Facilities*
System Approach for Emergency Response (SAFER)	Real-time	Employs standard Gaussian dispersion modeling equations; can be linked for real-time meteorological data; can model various types of release scenarios	About $75,000; varies with choice of hardware and needs of facility	20
Texas Episodic Model (TEM)	Planning	A Gaussian plume model; focuses on short-term releases of nonreactive pollutants; accepts meteorological data; operates on IBM PC.	$80	10
Industrial Source Complex Short Term (ISCST)	Planning	Uses Gaussian dispersion equations to model chemical releases primarily for disaster analysis. Operates on PC with meteorological data inputs.	$100-150	9
DEGADIS	Planning	Developed for Coast Guard to predict contaminant movement for heavier than air gases; capable of modelling instantaneous and continuous ground level releases.	Public Domain	7
Complex Hazardous Air Release Model (CHARM)	Real-time	Includes chemical data base and map editors; capable of mapping concentration isopleths; allows real-time meteorological data input.	$9,500-15,000	5
Puff	Planning	Applicable only to five neutral or buoyant gases (Gaussian puff dispersion); designed to incorporate type of short-term release, emission rate, facility characteristics, and weather data.	$200-450	3
Texas Climatological Model (TCM)	Planning	A climatological steady-state Gaussian plume model for determining long-term average pollutant concentrations of non-reactive pollutants.	$100-150	3
Hazard Assessment System for Toxic Emissions (HASTE)	Planning	Intended for planning; includes models and graphic presentation; no weather inputs.	$78,600-basic system; $50,000-added options	3

System/Model Name	Capability	Description/Requirements	Cost Estimate	Facilities*
Computer Assisted Management Emergency Operations (CAMEO)	Planning	Provides the following: chemical information, response information, air modelling, mapping, response resources, inventory, emergency contacts, facility information, route information, population information, vulnerability zone designations, and release records; requires Apple computer.	Public Domain	1
Emergency Information System (EIS)	Planning	Capability includes data base records of chemicals, facility characteristics, transportation routes, vulnerability zones, geographical layout.	$4,000	1
Meteorological Information and Dispersion Assessment System (MIDAS)	Real-time	A plume trajectory model; calculates the impact of releases under routine or accident conditions; covers 14 scenarios using features of Gaussian model equations and heavy gas dispersion algorithms (DEGADIS)	$55,000-100,000	2
World Bank Hazard Analysis (WHAZAN)	Planning	Models chemical dispersion and spill behavior; 13 mathematical models assess data base of 30 hazardous substances to predict effect.	$1,000	1
Energy Analysts Hazard Analysis Package (EAHAP)	Planning	Contains 3 models; OOMS model for pressurized releases; DEGADIS for heavier than air gases; Gaussian for neutral or buoyant gases; covers 7 release scenarios and uses weather data manually entered; runs on IBM PC.	$75,000	3
Other Models/Systems				20

* Several facilities use more than one model.

Appendix 7
Public Alert

LIST OF EXHIBITS

Exhibit A 7-1

PRIMARY WARNING TECHNOLOGIES
% of communities

	Public within 1 mile of facility	Public 1 to 5 miles from facility	Institutional facilities within 5 miles	Transient populations
Permanent sirens	43.4	39.0	27.9	22.8
Tone-alert radio	12.5	11.8	19.9	4.4
Telephone ring-down system	2.2	3.7	10.3	1.5
Fixed loud-speakers/public address	10.3	10.3	10.3	5.1
Emergency broadcast system	48.5	52.9	35.3	34.6
Door to door	30.1	19.9	17.6	7.4
Portable sirens/ loudspeakers on vehicles	50.0	43.4	22.1	36.0
TV/radio	44.1	49.3	35.3	36.8
Cable override	20.6	22.1	13.2	10.3
Commercial telephone	14.0	10.3	38.2	4.4
Two-way radio	10.3	10.3	12.5	3.7
Air or helicopter	3.7	3.7	2.2	2.2
Other	1.5	1.5	1.5	4.4

S84042-1a

Exhibit A 7–2

SECONDARY WARNING TECHNOLOGIES

% of communities

	Public within 1 mile of facility	Public 1 to 5 miles from facility	Institutional facilities within 5 miles	Transient populations
Permanent sirens	2.2	3.7	3.7	6.6
Tone–alert radio	3.7	2.2	3.7	1.5
Telephone ring–down system	2.2	2.2	2.2	1.5
Fixed loud–speakers/public address	7.4	7.4	6.6	5.1
Emergency broadcast system	20.6	16.9	22.1	11.8
Door to door	48.5	49.5	41.9	26.5
Portable sirens/loudspeakers on vehicles	36.0	44.1	35.3	26.5
TV/radio	36.0	33.8	30.9	19.9
Cable override	24.3	22.8	19.9	11.0
Commercial telephone	24.3	23.5	19.9	10.3
Two–way radio	13.2	11.8	12.5	5.1
Air or helicopter	16.2	16.2	13.2	9.6
Other	1.5	1.5	2.2	0

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EXHIBIT A 7-3

COST ESTIMATES: A WARNING SYSTEM OF 3 SIRENS

Device and Unit Costs	Total Costs ($)
122 dB: 3 @ $10,000	30,000
Site Selection	252
Installation	4,080
Power Hook-up	2,580
Administration	1,440
One-Time Costs	38,352
Annual Maintenance	1,035
Annual Power Cost	216
Annual Testing	600
Annual Administration	360
Annual Costs	2,211
One-Time Cost:	$38,352
Annual Costs:	$ 2,211

EXHIBIT A 7-4

COST ESTIMATES: A WARNING SYSTEM OF 50 SIRENS

Device and Unit Costs	Total Costs ($)
122 dB: 50 @ $10,000	500,000
Site Selection	4,200
Installation	68,000
Power Hook-up	43,000
Administration	24,000
One-Time Costs	639,200
Annual Maintenance	17,250
Annual Power Cost	3,600
Annual Testing	10,000
Annual Administration	6,000
Annual Costs	36,850
SUBSYSTEM COSTS	
One-Time Cost:	$ 41,832
Total Annual Costs:	$ 2,651
TOTAL SYSTEM COST	
Total One-Time Cost*	$681,032
Total Annual Costs:**	$ 39,501

* Does not include cost of transmitters

** For 1 year only.

EXHIBIT A 7-5

COST ESTIMATES: A WARNING SYSTEM OF 1900 RESIDENTIAL GRADE TONE ALERT RECEIVERS

Device and Unit Costs	Total Costs ($)
Residential TAR: 1900 @ $55	104,500
Installation	15,675
Administration	5,700
One-Time Costs	125,875
Annual Maintenance	20,900
Annual Power Cost	6,650
Annual Testing	1,900
Annual Administration	14,250
Annual Costs	43,700
SUBSYSTEM COSTS	
One-Time Cost	$ 41,832
Annual Costs:	$ 2,651
TOTAL SYSTEM COST	
Total One-Time Costs:*	$167,707
Total Annual Costs:**	$ 46,351

* Does not include cost of encoder.
** For 1 year only.

EXHIBIT A 7-6

COST ESTIMATES: WARNING SYSTEM OF 10 COMMERCIAL GRADE TONE ALERT RECEIVERS

Device and Unit Costs	Total Costs ($)
Commercial TAR: 10 @ $300	3,000
Installation	450
Administration	30
One-Time Costs	3,480
Annual Maintenance	300
Annual Power Cost	35
Annual Testing	30
Annual Administration	75
Annual Costs	440
One-Time Cost:*	$ 3,480
Annual Costs:**	$ 440

* Does not include cost of encoder.
** For 1 year only.

EXHIBIT A 7-7

COST ESTIMATES: AUTOMATIC TELEPHONE DIALERS (USING THE BUTLER NATIONAL ADAS VI: $20,000/UNIT)

Device and Unit Costs	Total Costs ($)
11 ATD @ $20,000	220,000
Installation	4,400
Data Entry	1,320
Administration	1,320
One-Time Costs	227,040
Annual Maintenance	2,200
Annual Power Cost	110
Annual Testing	2,200
Annual Administration	1,320
Annual Line Charge	31,680
Annual Cost	37,510
SUBSYSTEM COSTS	
One-Time Cost:	$ 41,832
Annual Costs:	$ 2,651
TOTAL SYSTEM COST	
Total One-Time Cost:*	$268,872
Total Annual Costs:**	$ 40,161

* Does not include cost of conversion to touch-tone telephone.

** For 1 year only.

EXHIBIT A 7-8

SUMMARY OF INITIAL AND ANNUAL COSTS FOR 5 ALTERNATIVE WARNING SYSTEM CONFIGURATIONS IN A 10-MILE SQUARE EMERGENCY PLANNING ZONE*

Alternative System Configuration	Cost, $** Initial	Annual***
Outdoor Warning Sirens	681,100	39,500
Residential Grade Tone Alert Receivers	167,800	46,300
Automatic Telephone Dialers	268,900	40,100
Outdoor Warning Sirens Residential Grade and Tone Alert Receivers	174,100	23,300
Automatic Telephone Dialers	234,600	24,900

* All configurations include the subsystem costs.
** Costs are rounded to the nearest $100.
*** For 1 year only.

EXHIBIT A 7-9

COST ESTIMATES: WARNING SIRENS AND RESIDENTIAL GRADE TONE ALERT RECEIVERS

Siren Costs		Residential Grade Tone Alert Receiver Costs	
Device and Unit Costs	Total Costs ($)	Device and Unit Costs	Total Costs ($)
122 dB: 7 @ $10,000	70,000	Residential TAR: 675 @ $55	37,125
Site Selection	588	Installation	5,569
Installation	9,520	Administration	2,025
Power Hook-Up	6,020	One-Time Costs	44,719
Administration	3,360	Annual Maintenance	7,425
One-Time Costs	89,488	Annual Power Cost	2,363
Annual Maintenance	2,415	Annual Testing	675
Annual Power Cost	504	Annual Administration	5,063
Annual Testing	1,400	Annual Costs	15,526
Annual Administration	840		
Annual Costs	5,159		

SUBSYSTEM COSTS
One-Time Cost: $ 41,832
Annual Costs: $ 2,651

TOTAL SYSTEM COST
Total One-Time Cost: $ 176,039*
Total Annual Cost: $ 23,336**

* Does not include cost of transmitters or encoder.
** For one year only.

EXHIBIT A 7-10

COST ESTIMATES: WARNING SIRENS AND AUTOMATIC TELEPHONE DIALERS

Siren Costs		Automatic Telephone Dialer Costs	
Device and Unit Costs	Total Costs ($)	Device and Unit Costs	Total Costs ($)
122 dB: 7 @ $10,000	70,000	5 ATD @ $20,000	100,000
Site Selection	588	Installation	2,000
Installation	9,520	Data Entry	600
Power Hook-Up	6,020	Administration	600
Administration	3,360	One-Time Costs	103,200
One-Time Costs	89,488	Annual Maintenance	1,000
Annual Maintenance	2,415	Annual Power Cost	50
Annual Power Cost	504	Annual Testing	1,000
Annual Testing	1,400	Annual Administration	600
Annual Administration	840	Annual Line Charge	14,400
Annual Costs	5,159	Annual Cost	17,050

SUBSYSTEM COSTS
One-Time Cost: $ 41,832
Annual Costs: $ 2,651

TOTAL SYSTEM COST
Total One-Time Cost: $ 234,520*
Total Annual Cost: $ 24,860**

* Does not include cost of transmitters or conversion to touch-tone telephone.

** For one year only.

EXHIBIT A 7-11

COST BREAKDOWN FOR FIVE ALTERNATIVE SYSTEM CONFIGURATIONS

Alternative System Configuration	Quantity	Hardware Costs, $*		Total Costs, $*	
		Unit	Total	Initial	Annual**
Outdoor Warning Sirens	50	10,000	500,000	639,200	36,900
Residential Grade Tone Alert Receivers	1,900	55	104,500	125,900	43,700
Automatic Telephone Dialers	11	20,000	220,000	227,000	37,500
Outdoor Warning Sirens	7	10,000	70,000	89,500	5,200
Residential Grade Tone Alert Receivers	675	55	37,100	44,700	15,500
			107,000	132,200	20,700
Outdoor Warning Sirens	7	10,000	70,000	89,500	5,200
Automatic Telephone Dialers	5	20,000	100,000	103,200	17,100
			170,000	192,700	22,300
Subsystem Common to All Alternatives					
Outdoor Warning Sirens	3	10,000	30,000	38,400	2,200
Commercial Grade Tone Alert Receivers	10	300	3,000	3,500	400
			33,000	41,900	2,600

* Costs are rounded to the nearest $100.

** For 1 year only.

Appendix 8
Expert Panel Summary

SUMMARY OF EXPERT PANEL DISCUSSIONS

Management Panel

The management panel conducted a qualitative assessment of the returned facility questionnaires. Recognizing that the questionnaires could not describe in full the hazards encountered at the facilities, the panel concluded that:

- About a third of the facilities appeared to be aware of the hazards and were employing good management practices to manage those hazards.
- Another third described substantial activity in the areas of training, accident investigation, and risk identification.
- About a quarter of the responses suggested that the inherent risks were not fully appreciated. Some of these risks may be minor.

The panel recommended a further study of the issue of managing process safety. Such a study should recognize that the entire management system must be evaluated and that the ability to differentiate between appropriate and inappropriate management involvement requires experience and understanding of the technical-managerial relationship.

The panel recommended for consideration the programs that AIChE and the Organization Resources Counselors have developed that outline good management practices for the manufacturing, handling, use, and storage of hazardous chemicals.

Prevention Panel

The panel on prevention made a number of recommendations, especially for research and technical transfer needs.

In the area of hazard evaluation techniques, the panel recommended that the techniques described in the AIChE guidance document be considered the "recognized, acceptable" methods. The panel strongly opposed any suggestion of a hierarchy of techniques and specifically stated that quantitative methods should not be considered preferable in all circumstances. The panel recommended that:

- A number organizations including AIChE and EPA could enhance their efforts to disseminate guidance on hazard evaluation, especially to smaller companies, which do not appear to recognize the need for hazard evaluations.
- Some organization should assume a central role to standardize hazard evaluation terminology.
- Source strength data and acute health effects data should be bolstered for use in hazard evaluations.

In the area of pre-release prevention and protection, the panel suggested that reducing risk in a facility is achieved primarily through redundant systems, interlocks, and management policies. Appropriate combinations of individual technologies are chemical- and process-specific, and, therefore, it is impossible to describe a generic best available technology for prevention, other than the best combination of the chemical engineering, materials engineering, and process controls that are applicable to a given situation. Given a quality design, the operating, maintenance, and management procedures are critical to safe operations.

Mitigation Panel

The panel stated that mitigating releases is generally less cost-effective than preventing releases. Because mitigation technologies are site-, process-, and chemical-specific, uniformity or consistency of application should not expected or desired. Mitigation approaches should be part of the overall risk management process and should not be considered in isolation. Because mitigation equipment is used rarely, it is critical that management practices ensure that the equipment is always operational.

The panel identified areas for further research:

- For releases directed to mitigation devices, such as scrubbers, flares, and stacks, improved design methods and approaches for handling large bursts are needed.

- For unconfined liquid/vapor releases, large scale demonstrations of the effectiveness of foams, water sprays/fogs/curtains, absorbents, reactants, and physical covers should be conducted, including demonstrations in adverse conditions.

- For releases of solids, the magnitude of the problem needs to be defined to determine if developing mitigation techniques is warranted.

The panel also suggested that water sprays/fogs/curtains should be considered for unconfined vapor releases, but that the nature of these releases makes them difficult to mitigate. Therefore, the emphasis should be on prevention.

Monitoring and Detection Panel

The panel concluded that where chemical-specific, reliable, operable, cost-effective detectors are available, at least some facilities are using them. Where detectors are seen as unreliable and not cost effective, they will not be used. The panel suggested further study to determine why certain systems are not being used and to investigate management's commitment.

The panel stated that significant advances can be made where no technology exists, and that for some existing technologies need to be modified to improve their reliable and cost-effectiveness.

The panel suggested that perimeter alert systems may not be useful for smaller releases. They also stated that, in general, it is better to spend money preventing accidents than to spend money on systems to monitor releases after accidents.

For models, the panel stated that real-time models must be validated and calibrated for specific sites. In general, the panel emphasized the need for good data to obtain good predictions.

Public Alert Panel

The panel indicated a number of areas where improved planning is needed: identification of contact points, notification of special groups such as institutions and transient populations, and cross-jurisdictional contacts. The panel felt the estimated public warning times given by respondents to the community survey pointed to problems in providing effective warning in rapid-onset events.

The panel recommended that communities develop independent technical expertise, rather than relying on the facility. The facilities should broaden their contacts with the community to include the media, health facilities, and emergency response units in their planning efforts.

The panel recommended that future research focus on:

- An analysis of alternative guidelines for the use of evacuation and sheltering.

- An analysis of response to actual chemical emergencies in light of the existence of planning bodies and activities mandated by Title III.

- An analysis of the warning process with attention to the effect of interpersonal communication and interaction.

- An analysis of the efficiency of public education programs in the warning process.

Appendix 9
Facility Site Visits

SUMMARY OF FACILITY SITE VISITS

To confirm and clarify reported information, EPA conducted seven site visits at facilities that had returned questionnaires. A team of Headquarters and Regional EPA personnel, trained by the AIChE in process chemical safety hazards, met with company staff at each facility and toured the process area. State EPA personnel also participated in some of the visits. These visits provided an opportunity to gain insight into management's operations and decision-making processes.

The team visited:

- Two acrylonitrile plants, a producer in Texas and a user (plastics manufacturing) in Illinois;
- Two phosgene plants, a specialty chemical liquid phosgene producer/marketer in Texas, and a plastics manufacturer in Indiana that produces and consumes phosgene onsite;
- A liquid sulfur dioxide and gaseous sulfur trioxide plant in New Jersey producing sulfuric acid;
- A regional drinking water chlorination operation; and
- A hydrofluoric acid distributor in California.

Several different factors were considered in selecting facilities:

- Unusual comments on the questionnaires, such an indication of unique systems or methods;
- Differences between facilities handling several hazardous substances and those handling a single chemical;
- The geographic distribution;
- The potential impact of a release, based on the chemical's toxicity, quantity stored or used, the population, and past releases; and
- The number of employees and the age of the facility.

Except in one case, the site visits generally confirmed the information provided in the questionnaire. This is not unexpected since the facilities agreed to the site visit. Most differences occurred because the respondent either did not fully understand a question or gave an incomplete answer. The one exception was the hydrofluoric acid importer who answered the questionnaire concerning warehouse distribution operations, but was apparently unfamiliar with actual daily operations and did not verify the information with the warehouse personnel.

The visits clarified, expanded, and emphasized certain areas of the survey data that were necessary to understand the methods of operation and management practices. For example, the sulfuric acid producer indicated on the questionnaire it was uncertain whether an effective warning could be given to the community in an emergency. Discussions revealed that the management had only minimal contact with the local response agencies because of coordination problems, and, therefore, had not conducted any drills or training exercises. The liquid phosgene producer stated it was the largest merchant/marketer of liquid phosgene in the country. However, due to the corporate management's perceived risks in transporting liquid phosgene by rail, it will withdraw from the business in 1989. Instead, it will make the phosgene-derived intermediate chemical onsite and ship this much less hazardous chemical to users.

The site visits also revealed some unique technologies and practices. The acrylonitrile producer in Texas has a unique mitigation technology in place at the barge loading area. A continuous bubble barrier is located across the entrance to the loading area which creates a water level one-inch higher than the surrounding water level. Thus, any surface or subsurface spills are contained and prevented from entering the bayou. No spill has ever spread beyond the barrier.

The phosgene producer in Indiana reported the use of containment around certain process equipment, but the visit showed the technology is used much more extensively. Any system that could contain gaseous or liquid chlorine under pressure has secondary containment. This includes storage vessels, pipes (through the use of an annulus), and flanges. Furthermore, the air evacuated from within the containment is continuously monitored for phosgene before being vented to continuously operated scrubbers. Also, by producing and consuming all phosgene onsite, transportation, unloading, and handling hazards are eliminated.

In the water supply operation, chlorine is transferred from 90-ton railroad tank cars into 17-ton tank trucks for distribution to five regional plants. Although these transfer operations are near a lightly populated area, special excess-flow control and check valves are used to prevent overfilling the trucks. Should these fail, special piping directs the chlorine into a vaporizer and water chlorinator. The chlorinated water is disposed in the underground tunnel used to transport the Colorado River water to the treatment site.

Overall, the site visits were very successful. Most companies expressed their appreciation at being able to show their commitment to environmental protection and safe operation, not only for their employees, but also for surrounding communities.

Chemical Unloading Facility, Metropolitan Water District of Southern California, Riverside, California

The 3-acre facility serves as the central liquid chlorine transfer point for five water treatment plants and reservoirs in the greater Los Angeles area. Maximum chlorine inventory is 600,000 pounds. Chlorine is transferred only during daylight hours. Four fill-time people are employed. The facility is subject to earthquakes and lies in the flight path of March Air Force Base.

Hazard and risk assessments are performed by Facility personnel and include definitions of likely accident scenarios based on industry incidents and Chlorine Institute information. Specific site safety needs are reviewed regularly and updated. Management's commitment to safety and training is the cornerstone in reducing risk to employees and the community. Standardized chlorine handling procedures have been developed and employees receive intensive initial training and refresher training on them. The procedures stress safety and leak detection measures and are used throughout the Greater Los Angeles areas' plants, reducing the chances of human error.

The greatest potential for a large chlorine release exists at the unloading dock where three 90-ton railroad tank cars may be located at one time. Chlorine arrives by rail, transferred to 17- or 19-ton tank trucks or 1-ton cylinders and is then shipped to the various water treatment plants. Both the rail cars and trucks are dedicated to chlorine service and are equipped with special valves and excess-flow control devices to prevent accidental releases. Chlorine is transferred using a pressure differential between the rail car and the receiving tank. Moisture monitors shut down the process if moisture is detected in the compressed air during transfer. Any excess chlorine from the transfer process is dissolved in water in a chlorinator. The chlorine solution is then injected into the Val Verde Tunnel which carries Colorado River water to various locations in southern California. Plant management believes the system's check valves, fault alarms, purging lines, and other built-in safety equipment make the facility inherently safe. The Facility was also designed to withstand major earthquakes.

Chlorine gas detectors provide continuous air monitoring at three locations: the transfer shelter, chlorinator room, and cylinder storage area. Audible and visual alarms are activated at the facility as well as at the central water district communications center.

The Facility has an emergency response plan which includes emergency phone numbers and safety data sheets. Employees are trained to take immediate emergency action to mitigate small leaks following rigid safety procedures. If a major leak occurred, local fire and police departments would take the lead in notifying the community as described in the Riverside County Emergency Response Plan. Facility safety and technical representatives would be available to assist local officials. The facility is investigating computerized air dispersion models, but has concerns about their accuracy and utility during emergencies.

The metropolitan water district has participated in several emergency exercises with local agencies, including an eight-hour command post exercise involving over fifty State and local personnel. The district has also conducted earthquake exercises to assess communications strategies and problems.

Borg-Warner Chemicals, Inc., Ottawa, Illinois

The Borg-Warner plant, which uses acrylonitrile to make plastics, occupies about 80 acres of a 238 acre tract and employs about 440 people. The plant is subject to tornados and lies within the New Madrid Seismic Zone, but has not experienced any damage in the past.

A consultant performed a hazard/risk assessment which emphasized consequences based on meteorological conditions rather than on the probability of accidents. Dispersion modeling was done to determine which weather conditions favored a "worst-case" scenario. Fire hazards, flashback potential, boiling liquid expanding vapor explosions, toxicity, and combustion products were also examined. Risk was not quantified numerically because failure rate data were unavailable for some equipment. Annual internal and external risk management audits by plant personnel use a "what if" approach.

Borg-Warner's pre-release prevention practices do not depend solely on the nature of the facility, its processes, and products, but are also based on government and industry reports, common sense, and experience. Their preventive engineering practices are specific to each chemical process and to the potential sources of a release, and are designed to confine releases within the facility's boundaries. Chemical inventories are kept at an absolute minimum for safety purposes and to reduce costs. Dump tanks are used to stop runaway reactions. Surge capacity is built into the processes to prevent releases from plant upsets.

Closed circuit television cameras continuously monitor the facility's grounds for safety and detection purposes. Visual inspections are used to detect malfunctioning equipment. Backup or override systems are not used. Borg-Warner considered the installation of perimeter monitoring devices and concluded that the complexity and cost of such a system was not warranted based on the risks associated with their facilities. General hydrocarbon monitoring is done at the source.

Borg-Warner has no designated emergency control center, although the main gate guardhouse would be the most likely place to establish one. The fire brigade leader has the authority to notify the community during business and non-business hours. The site manager, assistant manager, and building manager serve as emergency advisory groups. Plant alarm codes, backed by radios and telephones, designate areas of the emergency during a release event. Firefighting foams are available to mitigate fires and large spills. The plant does not have a hazardous materials response team.

The LEPC depends extensively on Borg-Warner's technical expertise. Plant personnel and resources are available to assist public officials in planning and training as well as during an emergency. Chemical quantity and release rate, combined with meteorological conditions, are the criteria used to determine when the local community is to be notified. The County Sheriff's office is the primary notification point. No public warning systems exist.

F&S Distributing Company, Vernon, California

The F&S Distribuging Company stores about 300 fifty-five gallon drums of hydrogen fluoride solution (100,000 pounds) for Westco Chemicals on a 2.5 acre site. The drums remain sealed while in warehouse storage awaiting wholesale distribution. F&S employs about 10 people. The facility is subject to earthquakes, although no damage has been caused in the past.

No formal hazard or risk assessment has been done. F&S has the material safety data sheets (MSDS) on hydrogen fluoride, but no additional information on handling and safety procedures.

Spills could occur during the loading or unloading of the drums as the result of drops or forklift procedures. No written plans exist for procedures to be followed in case of a spill. Soda ash is available for neutralizing spills, but no training program exists on how to mitigate a spill or use safety equipment. The drums are stored on a flat concrete floor without berms. F&S hired a consultant to provide hazardous materials driver-training to their employees. One problem is that the training information and MSDSs are in English, but most of their employees are hispanic.

The warehouse has a fire alarm that can be heard at a nearby fire station and is also electronically tied into the station. The local fire department has a catalogue of materials stored at the warehouse and makes quarterly fire safety inspections. No practice drills or coordination with local officials has been done.

Monsanto Chemical Company, Alvin, Texas

Acrylonitrile is produced, with a maximum storage capacity of 34.8 million pounds. The facility occupies 500 acres of a 3000 acre tract. Monsanto employs about 875 people. Although the plant is subject to hurricanes and is above the 100-year flood plain, they have recently experienced two 500-year floods.

The HAZOP method is used by corporate personnel in all projects exceeding $2 million. Corporate safety also uses a "what if" audit to determine what quantities of spilled materials would go beyond the plant boundaries. Plant management does not consider acrylonitrile to be acutely hazardous; therefore, a specific hazard analysis on the acrylonitrile production units and storage area has not been done.

Redundant interlock systems are used to isolate specific process units to prevent runaway reactions and to ensure safe shutdowns. Main controls and instruments are hard-wired into the control panels and not tied into the computer software; thus, loss of computerized control does not create unsafe conditions. Maintenance programs include regular inspecting of vessels, ultrasonic thickness testing of tanks, tab testing for corrosion rates, and x-ray, dye penetrant, and metallurgical testing of welds. The entrance to the barge loading area on the bayou has a continuous air-bubble barrier that raises the surface level of the water about one inch, preventing any spills from escaping into the bayou.

Monsanto developed their own automatic continuous air monitoring system for acrylonitrile since, at that time, commercial systems were not available. The system is a multi-point chromatograph which uses 53 sensing heads plant-wide. One system is located in the storage area and one in the production area. No perimeter monitors are used.

The guard station at the main gate serves as the emergency response center. A mobile van, fully equipped with radios and emergency response gear, is the alternate center. An internal radio information system with a siren alerts employees. The plant maintains two trained, self-sufficient emergency response teams; a medical emergency team and a fire control/hazardous chemical spill team. High-density foam and hazardous materials foams are available to mitigate fires and spills. Monsanto has developed and verified spill models in-house. These are available on the main-frame computer at corporate headquarters; plant personnel have dial-up access. They have investigated the SAFER system but feel its accuracy is vulnerable to input data which may not be known in an emergency. Corporate headquarters has several models for off-line analysis to determine local impact of releases, but they would not be used in real-time.

Monsanto, in cooperation with two other local chemical companies, has installed a warning horn to alert local community residents and conducted emergency response drills with the community. Company representatives serve on the local LEPC.

PPG Industries, LaPorte, Texas

Liquid phosgene is produced for sale and used on-site as an intermediate for specialty chemicals. Maximum phosgene inventory is 50,000 pounds. Although this plant is the largest merchant/marketer of liquid phosgene in the country (40 million pounds per year), they will stop transporting liquid phosgene by rail in 1989 due to corporate management's concern about the transportation risks involved. The facility occupies 30 acres of a 515 acre tract. PPG employs about 122 people. The plant is subject to hurricanes, but has never experienced any flooding or damage.

Process reliability studies are done by either a corporate-level reliability engineer or a contractor, using a fault tree analysis. Informal "what if" hazard analyses are also done by plant management during process engineering reviews. PPG considers liquid phosgene more hazardous than gaseous phosgene. Therefore, plant practice is to transfer only gaseous phosgene within the plant. If liquid phosgene is needed, it is vaporized, transferred, then recondensed to liquid.

When PPG purchased the plant in 1979, Pyrex glass pipe was used throughout the plant to prevent corrosion from acidic products. PPG recently completed a $1 million project to replace most of the Pyrex with teflon-lined steel pipe, preventing recurring leak problems. Main controls are both computerized and hard-wired so that emergency shut-down can be done either through the computer or manually. The computer system and field instruments use a non-interruptible power supply in case commercial power is lost. Critical pumps and pollution control devices have diesel power backup.

Four phosgene-sensitive tape monitors are used in the process areas: one 8-point monitor in the production section and two 12-point and one 8-point in three other phosgene areas. PPG has three 4-point perimeter monitoring units on their fence lines. PPG will replace these units with 20 single-point monitors, costing about $185,000.

PPG's laboratory building near the main gate or the north-side guard shack serves as the emergency response center. The plant manager or shift supervisor has the authority to respond in case of an emergency. The plant has a SAFER computer modeling system to aid in responses. Although originally purchased to help predict plume movement, the system has evolved into a training and planning tool to educate employees on the consequences of releases to the surrounding area.

PPG participates in a mutual-aid radio net set up by local industry which would be used to alert and seek assistance from one another. The plant manager also serves on the local LEPC. A siren and voice communications public alert system was recently installed in LaPorte and has not been fully tested. PPG participates with local community agencies in mock disaster drills. For in-plant notification, they have a voice-synthesized public address system which allows employees to report emergencies without removing protective equipment.

General Electric Company, Mt. Vernon, Indiana

Chlorine and phosgene are made and used on-site in the production of high-density plastics. Chlorine and phosgene storage is about 250,000 pounds and 10,000 pounds, respectively. The facility occupies 300 acres of a 1000 acre tract. About 3600 people are employed. The plant is subject to tornados and is located in a region with an earthquake history.

A contractor performed a probabilistic risk assessment on the GE facility to define likely accident scenarios, assign event probabilities, and model consequences for the surrounding population. The analyses cost about $100,000. The plant's management has set the "acceptable" risk level at 10 deaths per million years. All GE plants are standardized toward the same level of safety, regardless of locale. GE reported spending over $60 million in design and engineering modifications to reduce risk.

All systems that contain gaseous or liquid phosgene or chlorine under pressure have secondary containment features. All pipes carrying phosgene or chlorine have an annular design with dry nitrogen sweep gas in the outer annular space. All tanks, compressors, and unit processes containing chlorine or phosgene are housed in containment buildings operated under vacuum. The nitrogen sweep gas and containment buildings are continuously monitored for chlorine or phosgene leaks; alarms automatically sound in the control rooms. The chlorine and phosgene facilities have separate emergency destruction systems (sodium hydroxide packed-tower scrubbers) which operate continuously to neutralize any releases. The nitrogen sweep gas and the sweep air from the vacuum system are also vented through continuously-operated packed-tower scrubbers which are independent of the emergency destruction system. The plant's structures are reinforced to withstand high winds and earthquakes.

Chlorine electrodes are used to detect free chlorine in the production area. Infrared detectors are used to detect phosgene in on-line processes and in the scrubber exhaust. Phosgene-sensitive tape monitors with photocell sensors operate continuously at 11 perimeter stations.

GE has two emergency response centers, one of which is always manned. A mid-level manager is assigned to the center on a rotating basis and has the primary authority to respond in case of an emergency. A SAFER computer modeling system is used for emergency responses in both centers. GE feels that SAFER allows real-time predictions. GE has pre-modeled some release scenarios and stored them in the computer's memory.

GE's plant alert system is integrated with the community's. The Local Emergency Planning Committee (LEPC) includes several GE employees and GE provides technical support. No-notice emergency drills are conducted about quarterly to test the emergency response centers.

Essex Industrial Chemicals, Newark, New Jersey

Gaseous sulfur dioxide and sulfur trioxide are produced to make sulfuric acid and oleum, plus liquid sulfur dioxide for sale. The maximum sulfur trioxide inventory (as 65 percent oleum) is 130,000 pounds; maximum liquid sulfur dioxide inventory is 800,000 pounds. About 125 people are employed on the 15 acre facility. While the plant is not subject to natural disasters, it lies in the flight path of Newark International Airport.

Essex uses a "what if" hazards evaluation developed in-house which involves corporate and plant staff, product supervisors, operators, mechanics, maintenance personnel, and process engineers. Essex does not use mathematical probabilities to define risk because they feel such numbers are ambiguous. They rely on their 30 years of operating experience and knowledge to determine accident possibilities.

Pre-release prevention is obtained through design engineering, operation and maintenance. The stainless-steel sulfur dioxide converter was the first of its kind installed in the country, representing the latest in converter technology. Corrosion is reduced by operating above the dew point of sulfuric acid. During the annual maintenance shutdown, the converter, heat exchangers, and piping are visually checked for corrosion and questionable areas are ultrasonically tested for thickness. For 1988, Essex has estimated that about 34 percent of their capital budget will be allotted for environmental projects, including retirement of process components to ensure against potential spills.

A photometric sulfur dioxide analyzer is installed in the stack to monitor routine emissions. However, due to maintainability and reliability problems, Essex rely on the Reich iodine titration test as the primary indicator of sulfur dioxide emissions. No perimeter monitors are installed because they feel that the presence of other sulfurous compounds in the area would cause interferences and false alarms.

Essex has reviewed the SAFER system but is concerned about its accuracy and its price. They are generally suspicious of computerized dispersion models and their predictions, as many hidden assumptions are usually made. They have a simple Gaussian dispersion model in a LOTUS spreadsheet format to predict releases from their stack, but do not have a computer model at the plant.

The administration office, opposite the main plant, serves as the headquarters for emergency response. An in-plant voice paging system is the primary notification method for employees, with telephones as backup. The plant manager or the shift supervisor has the authority to notify the state and local officials in an emergency. Public officials would be notified by telephone.

Plant management has experienced communications problems with the Newark LEPC. Management has made only introductory contact with the local response agencies and has not conducted any drills with them. The Newark fire department and their HAZMAT team have toured the plant. Plant management feels they could alert and evacuate their own personnel, but are concerned about the efficiency of the responding organizations since they have not coordinated or participated with them in drills.

Appendix 10
EPA's Accidental Release Information Program

EPA'S ACCIDENTAL RELEASE INFORMATION PROGRAM

In 1987, EPA instituted the Accidental Release Information Program (ARIP). The purpose of this program is to focus corporate management attention on potential chemical accidental problems, stimulating them to take initiatives to prevent accidents. In addition, ARIP is designed to establish a national data base that contains detailed information about the causes and circumstances of chemical accidents, as well as about the actions taken by industry to prevent and prepare for such releases. Several currently available data bases contain records of accidental releases that have occurred, but none has complete and reliable details of the circumstances surrounding accidental releases. In addition, not much is known, aside from the Section 305(b) review, about current industry prevention practices.

Facilities that have received an ARIP questionnaire were selected from the National Response Center (NRC) data base, which is operated by the Transportation Systems Center of the Department of Transportation. In accordance with CERCLA requirements, facilities must report to the NRC all releases of hazardous substances that exceed the Reportable Quantity (RQ) established for that chemical. Facilities that met one or more of the following three criteria are targeted for ARIP letters.

(1) Multiple Releases - The facility experienced two or more releases that exceeded the Reportable Quantity within a 12-month period;

(2) Exceed a Multiple of RQ Release - The facility experienced a release of 1,000 pounds or more of a chemical with an RQ of 1, 10, or 100 pounds or a release of 10,000 pounds or more of a chemical with an RQ of 1,000 or 5,000 pounds;

(3) Death/Injury - The facility experienced a release that caused death or injury.

EPA used a two-phase approach to gather the necessary accidental release information. First, the Agency conducted a pilot test of the ARIP questionnaire in EPA Region IV in early 1987. Facilities who met the criteria were sent a questionnaire along with a letter requesting their completion of the questionnaire for each release -- pursuant to several statutory authorities, including CERCLA section 104(e). Based on the results of the pilot test, EPA revised the letter and the questionnaire and adopted other survey administration changes suggested by the pilot study. In the second phase of ARIP information-gathering approach, the questionnaire was distributed nationally to facilities that met the criteria. By April 1988, 103 questionnaires had been returned. Because the sample size is limited, the results are not intended to be statistically valid or representative of all facilities with releases. The Agency is currently undertaking an evaluation of ARIP. It plans to refine the questionnaire and decide whether to pursue a regulatory approach to obtain the necessary information.

As the information from ARIP is received, it is entered into a data base. EPA will be evaluating these data and producing reports summarizing the causes of chemical accidents, effective and ineffective techniques to prevent a release, and recommendations for prevention programs to decrease the likelihood of accidental releases. The information data base and report findings will be appropriately disseminated to support other on-going government efforts addressing accidental releases and to raise the level of awareness in industry and in the community concerning the need for preparedness and prevention. The report and data base also will be made available to state and local governments through the SERCs and LEPCs to support emergency response services and contingency planners.

Industry will be encouraged to review important findings and conclusions to learn about effective industry-wide practices. Headquarters will provide the findings of the report to professional organizations (AIChE, ASSE), trade associations (API, CMA) and public interest groups when discussing guidelines and technologies.

The following tables present response data to four key questions in the ARIP survey. The survey asked what types of release prevention measures the facilities used (Exhibit A 10-1), what immediate activities were taken in response to a release (Exhibit A 10-2), what short-term cleanup activities were implemented to restore or improve release prevention (Exhibit A 10-3), and what additional, long-term measures are planned to prevent future releases (A 10-4). Each exhibit provides a frequency count indicating the number of times a response was given, and a percentage indicating the percentage of surveys that included the specific responses.

Exhibit A 10-1

ARIP QUESTIONNAIRE RESPONSES
RELEASE PREVENTION PRACTICES

Survey Question Response	Frequency*	Percent of 103 Surveys
Operator monitoring and inspection program	21	20
Instrument for operation monitoring and warning	14	14
Release prevention equipment	5	5
Preventive maintenance	8	8
Containment	37	36
Standard Operating Procedures	31	30
Training	66	64
Release control plan	27	26
Equipment installation checks	1	1
Emergency equipment available for release mitigation	23	22
Release detection equipment or warning system	4	4
Divert release to wastewater treatment plant	3	3
None	3	3
Other	18	17

*Note: Surveys permitted more than one response.

Exhibit A 10-2

ARIP QUESTIONNAIRE RESPONSES
IMMEDIATE RESPONSE ACTIVITY

Survey Question Response	Frequency*	Percent of 103 Surveys
Reduce system pressure	16	16
Apply spray scrubber	11	11
Shut or open valves	26	25
Isolate feeds	20	19
Transfer contents from failed equipment	17	17
Dilute or neutralize release	29	28
Activate fire fighting equipment	6	6
Containment	29	28
Plant/process shutdown	19	18
Divert release to wastewater treatment plant	8	8
Remove, dispose, treat contaminated soil	12	12
None	1	1
Other	13	13

*Note: Surveys permitted more than one response.

Exhibit A 10-3

ARIP QUESTIONNAIRE RESPONSES
POST RELEASE CHANGES IN PREVENTION METHODS

Survey Question Response	Frequency*	Percent of 103 Surveys
Monitoring equipment: install/repair/replace	14	14
Process equipment: inspection	15	15
Process equipment: upgrade/refine	50	49
Training	13	13
Review/change standard operating procedures	24	23
Change equipment settings	1	1
Change preventive maintenance procedures	4	4
Repair/install/expand/improve containment	18	17
Expand capacity	2	2
Install emergency backup systems	4	4
Review/change monitoring procedures	6	6
Better labeling of process equipment	3	3
Check for similar problems and upgrade equipment	4	4
Install pad to prevent soil contamination	3	3
None	3	3
Other	17	17

*Note: Surveys permitted more than one response.

Exhibit A 10-4

ARIP QUESTIONNAIRE RESPONSES
ADDITIONAL PREVENTION METHODS PLANNED

Survey Question Response	Frequency*	Percent of 103 Surveys
Regular equipment inspections	16	16
Regular review of operating procedures	3	3
Preventive maintenance	10	10
Evaluate/install backup equipment	3	3
Evaluate/install monitoring equipment	6	6
Install/change containment	6	6
Refine/upgrade SOPs	14	14
Expand operator training	16	16
Equipment upgrade	16	16
Participation in audits/seminars	4	4
Change equipment settings	1	1
Refine/improve process	4	4
Check for similar and upgrade equipment	4	4
None	20	19
Other	16	16

*Note: Surveys permitted more than one response.

Appendix 11
International Activities

PREVENTION OF CHEMICAL ACCIDENTS

INTERNATIONAL ACTIVITIES

BILATERAL

The U.S. is currently working with Mexico and Canada on a number of prevention activities. In January 1988, the U.S. and Mexico signed a Joint Contingency Plan for Accidental Chemical Releases Along the Border. As part of the planning process, 28 cities along the border were identified as areas in which principal planning activities must take place. The Plan calls for the development of plans for the 14 so-called Sister Cities on either side of the inland border. Among preventive measures in these plans are: (1) identification of hazards; (2) exchange of information on chemicals; (3) development of inventories, and (4) recognition of safety practices. These activities also include providing training and technical assistance to local communities on appropriate mitigation and cleanup procedures as well as on protection of workers onsite.

The U.S. and Canada are developing a joint contingency plan similar to that with Mexico to deal with chemical accidents.

MULTILATERAL

The U.S. has been involved over the past year in intensive efforts at the international level to focus more attention on chemical incidents. In February 1988, the Fourth High Level meeting of the Organization for Economic Cooperation and Development (OECD) member nations adopted a set of goals to prevent and respond to accidents involving hazardous substances. They are:

1. To limit the frequency and severity of accidents through better measures to prevent releases of hazardous substances;

2. To prevent adverse effects from accidents through better land use planning; and

3. To mitigate the consequences of accidents through the development of adequate emergency plans and measures.

The OECD Environment Committee recognized the need for a continuing forum that would provide the opportunity for member nations to continue to exchange information on a wide variety of policy and technical issues and to share this information with developing countries through the United Nations Environment Program (UNEP). Specific issues the forum will address include:

1. Consideration of broad policies established or required in the field;

2. Explanation of individual country program initiatives of cross-nation utility and interest; and

3. A wide variety of specific technical subjects such as

a. Dispersion models for dense gas.

b. Information management methodology.

c. New techniques in response and cleanup.

d. Networking of accident data bases.

e. Technology for prevention and mitigation.

f. Response technical assistance.

g. Risk assessment and effectiveness in planning and in management practices.

There will be approximately five meetings of this forum over the next year, beginning in June 1988.

Member countries were encouraged to promote appropriate legislative, regulatory, or administrative measures required to meet these goals. Several areas were suggested for consideration in developing adequate safety and prevention measures that include: (1) identifying hazardous installations that require special preventive measures; (2) establishing a licensing or permitting system for installations; (3) evaluating risk assessments or safety studies of hazardous installations; (4) conducting an effective inspection program; and (5) ensuring appropriate zoning and land-use policies for new installations handling hazardous chemicals.

UNEP has developed a data base on chemicals that could serve as a central point for countries to access. The U.S. is also supporting the development of guidance on planning for chemical emergencies. This document, entitled the Handbook on Awareness and Preparation for Emergencies at the Local Level (APELL) is expected to be published in the fall of 1988.

Appendix 12
Facility Questionnaire

Form Approved
OMB Number 2050-0079

SURVEY OF MONITORING, DETECTION, RELEASE PREVENTION, AND PUBLIC ALERT SYSTEMS FOR EXTREMELY HAZARDOUS SUBSTANCES

Please see the instructions for clarification of these questions. (Instructions are provided for all but the self-explanatory questions). If you require additional clarification for any question, please use the telephone number provided on page 3 of the questionnaire.

Facility Name: ______________________________

Facility Location: ______________________________
No. Street

____
City County State Zip

Parent Company, if any: ______________________________

Nature of Business: ______________________________

SIC Code(s): ______________________________

Dun & Bradstreet ID#: ______________________________

SECTION 1: EXTREMELY HAZARDOUS SUBSTANCES

1.1 Does this facility use, store, process, produce, manufacture, import, or package any of the extremely hazardous substances listed below in quantities larger than the threshold planning quantity (TPQ)?

YES__ NO__

If "YES," please complete the entire questionnaire.

If "NO," please provide the information requested in Question 1.2, sign, and return pages 1, 2, and 3 of the questionnaire to the address indicated on page 3 of the questionnaire.

1.2 Indicate the maximum quantity present at any one time of each substance listed below that is handled at your facility in quantities greater than the TPQ.

NAME	CAS No.	TPQ (lbs)	MAXIMUM QUANTITY (lbs)
Acrylonitrile	107-13-1	10,000	______
Ammonia	7664-41-7	500	______
Benzenearsonic Acid	98-05-5	10*	______
Benzotrichloride	98-07-7	100	______
Chlorine	7782-50-5	100	______
Chloroacetic Acid	79-11-8	100*	______
Furan	110-00-9	500	______
Hydrazine	302-01-2	1,000	______
Hydrocyanic Acid	74-90-8	100	______
Hydrogen Fluoride	7664-39-3	100	______
Hydrogen Sulfide	7783-06-4	500	______
Mechlorethamine	51-75-2	10	______
Methiocarb	2032-65-7	500*	______
Methyl Bromide	74-83-9	1,000	______
Methyl Isocyanate	624-83-9	500	______
Phosgene	75-44-5	10	______
Sodium Azide	26628-22-8	500	______
Sulfur Dioxide	7446-09-5	500	______
Sulfur Trioxide	7446-11-9	100	______
Tetraethyltin	597-64-8	100	______
Trichloroacetyl chloride	76-02-8	500	______

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* TPQ for these solids is 10,000 pounds if the solid is not in powdered, solution, or molten form, or does not meet certain reactivity criteria (see 40 CFR 355.30).

1.3 Please provide the following information for the person at your facility we may contact regarding your response to this questionnaire.

NAME of CONTACT PERSON: ______________________________

TITLE: ______________________________

ADDRESS: ______________________________

PHONE: (   ) ______________________________

THIS QUESTIONNAIRE IS SUBMITTED BY: ______________________________

TITLE: ______________________ DATE: ______________

RETURN TO:

U.S. Environmental Protection Agency
Section 305(b) Survey
P.O. Box 2734
Fairfax, Virginia 22031

IF YOU HAVE ANY QUESTIONS CONCERNING THE QUESTIONNAIRE, PLEASE FEEL FREE TO TELEPHONE (703) 934-3950.

SECTION 2: FACILITY INFORMATION

2.1 Total number of employees at your facility: ____________________

2.2 Number of production and/or other workers directly involved with the designated substance: ______________________________________

2.3 What is the longitude and latitude of your facility?

Longitude: Degrees_____ Minutes_____ Seconds_____

Latitude: Degrees_____ Minutes_____ Seconds_____

2.4 Please provide a facility sketch (see sample and further directions in instructions).

2.5 What is the fenceline area of this facility (in acres)?

2.6 What is the approximate average population density within a 2-mile radius of your facility?

2.7 What is the average distance from the process and storage areas for the designated substance to your property line?

2.8 What factors were used to establish the above given boundaries between process and storage areas, fenceline, and property line?

2.9 Does your facility have a safety/loss prevention officer?

YES ___ NO___

NAME: _________________

2.10 Does your facility have a department that deals solely with safety/loss prevention?

YES ___ NO___

2.11 How many individuals at your facility are working full-time specifically on safety/loss prevention issues?____
Part time?________________________

2.12 Does your facility report to a corporate-wide safety officer or department?

YES___ NO___ Not Applicable___

2.13 Please attach a simple organizational chart for your facility showing management responsibility for safety/loss prevention.

2.14 Please briefly describe training required at your facility for all levels of employees in the table provided below. Indicate the frequency of retraining (see instructions for sample).

TRAINING		FREQUENCY OF RETRAINING	
STAFF	MGMT	STAFF	MGMT

2.15 Please describe management activities related to safety/loss prevention in the table provided below (see instructions for clarification and sample).

MANAGEMENT ACTIVITIES	FREQUENCY

2.16 Does your facility participate in the Community Awareness and Emergency Response (CAER) program of the Chemical Manufacturers Association?

YES___ NO___ OTHER PROGRAM___

If "OTHER," please describe below.

2.17 What procedures do you have in place, or have you used, to investigate chemical accidents that occur at your facility, specifically those involving the designated substance?

2.18 What do you do with chemical accident investigation findings? To whom does your facility report these findings?

2.19 Describe changes in your facility or in your operations during the last 5 years to reduce the potential for, or the frequency and severity of, accidental releases of the designated substance.

2.20 Comment on the effectiveness of the changes indicated above.

2.21 Is your facility unusually susceptible to natural disasters (flood, severe storms, volcano, hurricane, tornado, earthquakes, etc.)?

YES___ NO___

If "YES," describe the particular natural disaster to which you are susceptible and measures you have taken to protect your facility.

SECTION 3: HAZARD ASSESSMENTS

3.1 For the designated substance, describe briefly the methodologies, if any, by which your facility identifies safety hazards.

3.2 How often are these methodologies employed?

3.3 Which of the methodologies identified in Question 3.1 has your facility used within the past year?

3.4 How often are these methodologies updated?

3.5 Which individuals or organizations perform assessments using the above-mentioned methodologies at your facility? Please include contractors and corporate personnel from off-site locations (if applicable) and their titles.

3.6 What conditions or events would trigger an unscheduled assessment or analysis using any of the methodologies identified in Question 3.1?

3.7 Describe actions taken after a potential hazard is identified.

3.8 When operational and process changes are made, including changes in both hardware and operating conditions, how are the safety aspects evaluated?

SECTION 4: PRE-RELEASE PREVENTION, PROCESS MONITORING, AND MITIGATION

4.1 Provide a simple flow diagram of the process(es) for manufacturing, processing, use, disposal, and/or handling of the designated substance. Show the flow or movement of the substance from its creation or entrance to your facility until its disposal or exit. (Please see the instructions for an example.)

4.2 When was this process or handling system constructed? ____________

4.3 When did the most recent major upgrade occur? ____________

4.4 Is the process line you diagrammed above dedicated to the manufacture, processing, or use of the designated substance?

YES___ NO___

4.5 Please describe any changes/modifications to your process or facility that were instituted as a result of significant changes in the facility neighborhood.

4.6 On the chart below list the codes for the process and chemical hazards you have identified for the process(es) previously diagrammed (Question 4.1). List codes for the release prevention or process control equipment used because of those hazards, process monitors, and techniques used to mitigate any releases that might occur. (Please see INSTRUCTIONS for an example and further explanation of information requested.)

Equipment Name	Location Number	Process Hazard Code	Chemical Hazard Code	Control Code	Monitor Code	Mitigation Code

4.7 On the chart below, list each control code you identified in Question 4.6 and briefly describe the rationale for the choice of this particular prevention or control device (please see instructions for an example).

Control Code	Rationale

4.8 How do you detect when control equipment is disabled or "down," and what systems do you have for backup or override in the event of a malfunction?

4.9 On the chart below, list each pre-release monitor code you identified in Question 4.6 and briefly describe the rationale for the use and choice of this particular technology.

Monitor Code	Rationale

4.10 How do you detect when this monitoring equipment is disabled or "down," and what systems do you have for backup or override in the event of a malfunction?

4.11 On the chart below, list each mitigation code you identified in Question 4.6 and briefly describe the rationale for the use and choice of this particular technique or technology (please see instructions for an example).

Mitigation Code	Rationale

4.12 How do you detect when mitigation equipment is disabled or "down," and what systems do you have for backup or override in the event of a malfunction?

4.13 On the chart below, show the frequency of inspection, audit, testing, and maintenance for each control and monitor you identified in Question 4.6.

Monitor or Control Code	Frequency of: Inspection	Audit	Maintenance	Testing

4.14 Describe the preventive maintenance (including frequency) for process equipment and storage units used by your facility.

4.15 Please attach any information on control/detection/monitoring/mitigation devices, approaches, or techniques used at your facility that are innovative or state-of-the-art.

4.16 Does your facility have any concerns regarding safety/loss prevention that have not been addressed in any of the above questions? Please explain below.

SECTION 5: AIR, WATER, GROUND WATER RELEASE MONITORING/DETECTION

5.1 On the chart below, indicate which ambient air, in-stack, waste water sewer, storm sewer, surface water, or ground-water monitoring devices you use to detect accidental releases, and describe the rationale for using those devices.

Detector/ Monitor Code	Rationale

5.2 How do you detect when this equipment is disabled or "down," and what systems do you have for backup or override in the event of a malfunction?

5.3 On the chart below, for each detector or monitor you identified in Question 5.1, show the frequency of inspection, auditing, testing, and maintenance.

Detector/ Monitor Code	Frequency of: Inspection	Audit	Maintenance	Testing

5.4 What mitigation techniques does your facility use (or would it use) if an accidental release has contaminated the ground water?

5.5 Describe any perimeter monitoring devices your facility uses for the designated substance. Please reference the submitted site sketch (Question 2.4).

5.6 If your facility has considered the installation of perimeter monitoring devices, or has installed such devices, please comment on your assessment of the economic feasibility of establishing, maintaining, and operating these devices.

5.7 Describe any off-site monitors your facility uses for the designated substance.

5.8 Describe the reliability or limitations of any perimeter or off-site monitoring systems used by your facility and the rationale for selection.

SECTION 6: MODELING

Please describe any models used at your facility to predict the movement of plumes of released chemicals through environmental media (see instructions for clarification). For each model described, indicate whether the model predicts chemical movement in (1) air, (2) ground water, or (3) surface water. Also indicate whether the model is used for (a) response or (b) planning.

SECTION 7: PUBLIC ALERT

7.1 How has your facility's emergency organization coordinated with each of the following agencies or organizations in the past several years? (Circle appropriate numbers below for each agency/organization)

Circle agencies that exist in your area	No Coordination at all	Initial introductory contact only	Developed emergency response plans with	On-going coordinated emergency effort	Participated in emergency exercises with*	
A. Fire/rescue dept.	0	1	2	3	4	____
B. Other internal facility emergency org.	0	1	2	3	4	____
C. Local/county police	0	1	2	3	4	____
D. Local emergency management/ civil defense	0	1	2	3	4	____
E. State police	0	1	2	3	4	____
F. Industry mutual aid assoc.	0	1	2	3	4	____
G. State emergency management	0	1	2	3	4	____
H. Hospital emergency rooms	0	1	2	3	4	____
I. State EPA	0	1	2	3	4	____
J. Others (incl. schools, nursing homes, etc.)						
__________	0	1	2	3	4	____
__________	0	1	2	3	4	____
__________	0	1	2	3	4	____

* For each agency/organization that you hold coordinated exercises with, please use the space under the right-hand column to enter the number of times in the last 2 years that you have held such exercises.

7.2 Describe the criteria used to determine when, if at any time, the local community is to be notified by your facility of a chemical release at your facility.

7.3 Describe the procedure your facility follows in notifying the local community once the above criteria are met.

7.4 Who at the facility makes the decision to notify the community? Is there a back-up person (identify by title)?

7.5 Who, if different from the above, makes the decision to notify the community during non-business hours in the event of an emergency?

7.6 Who, if different from the above, actually notifies the community?

7.7 Describe procedures used to inform and update the following groups during emergency situations.

(a) Personnel at Facility

(b) Local Community

7.8 Are the above described notification procedures, including all methods of communication, tested during safety audits or emergency exercises?

ALL___ SOME___ NONE___

Please explain.

7.9 Based on past experience, if any, please estimate the time required to notify the community or the population within a 5-mile radius of your facility of an accidental release.

7.10 Indicate the personnel and other resources available from your facility to assist public officials

Personnel/Resource	In planning, preparedness and training	In an emergency
Expertise or tech assistance	________	________
Fire brigade/dept.	________	________
Emergency team	________	________
HazMat team	________	________
Decontamination team	________	________
Medical personnel	________	________
Decontamination equipment	________	________
Monitoring equipment	________	________
Protective equipment	________	________
Containment equipment	________	________
Cleanup equipment	________	________
Other ____________	________	________
Other ____________	________	________
Other ____________	________	________

7.11 What do you consider to be the major problems and constraints to getting a timely and effective warning to the public around your facility in the event of an emergency (please attach additional sheets, if necessary)?

7.12 What is your overall assessment of your facility's capability to provide an alert in the event of an emergency?

a) Within the facility

____It is certain that an effective warning would be made.
____It is somewhat certain that an effective warning would be made.
____It is somewhat uncertain that an effective warning would be made.
____It is highly uncertain that an effective warning would be made.

b) To the community

____It is certain that an effective warning would be made.
____It is somewhat certain that an effective warning would be made.
____It is somewhat uncertain that an effective warning would be made.
____It is highly uncertain that an effective warning would be made.

SECTION 8: NEW PREVENTION, CONTROL, DETECTION, MONITORING, OR RELEASE MITIGATION TECHNOLOGIES

8.1 Describe any programs you conduct at your facility or within your company for the development/testing of new technologies for:

(a) Detectors

(b) Monitors

(c) Alarm/Public Alert Systems

(d) Control Devices

(e) Hazard Identification/Evaluation

(f) Intrinsically Safer Chemicals/Processes

(g) Pre-release Prevention

(h) Pre-release Protection

(i) Post-release Mitigation

(j) Reactive Chemicals

(k) Storage and Transfer of Hazardous Materials

(l) Human Factors

(m) Modeling of Releases (Source Strength and Dispersion)

(n) Process Measurement

(o) Other

8.2 Please describe any problems or weaknesses you have noticed or experienced with:

(a) The control devices specified in Questions 4.6 and 4.7.

(b) The detector devices specified in Question 5.1.

(c) The monitoring devices specified in Sections 4 and 5.

(d) The mitigation devices or procedures specified in Questions 4.6, 4.11, and 5.4.

(e) The models specified in Section 6.

(f) Alarm/public alert systems.

(g) Other

8.3 Are there any specific areas of research that you believe should receive greater support and attention by industry, government, or both? Please explain.

8.4 Were there any hazards (Question 4.6) for which control, detection, monitoring, or mitigation techniques are either outdated, outmoded, or non-existent? Please explain.

(a) Detectors

(b) Monitors

(c) Alarm/Public Alert Systems

(d) Control Devices

(e) Hazard Identification/Evaluation

(f) Intrinsically Safer Chemicals/Processes

(g) Pre-release Prevention

(h) Pre-release Protection

(i) Post-release Mitigation

(j) Reactive Chemicals

(k) Storage and Transfer of Hazardous Materials

(l) Human Factors

(m) Modeling of Releases (Source Strength and Dispersion)

(n) Process Measurement

(o) Other

8.5 Your comments are welcome. Please feel free to make them below.

Appendix 13
Community Questionnaire

SECTION 305(b) TITLE III
Superfund Amendments and Reauthorization Act of 1986

COMMUNITY SURVEY TO REVIEW PUBLIC ALERT AND WARNING SYSTEMS FOR CHEMICAL PLANT EMERGENCIES

(Form Approved; OMB# 2050-0079)

U.S. ENVIRONMENTAL PROTECTION AGENCY

FEDERAL EMERGENCY MANAGEMENT AGENCY

OAK RIDGE NATIONAL LABORATORY

December 1987

INTRODUCTION

In the letter introducing this questionnaire, a facility or company was identified, that according to EPA records, is located within your community.

Is this facility or company in your community and jurisdiction? (circle response)

1 YES, IN COMMUNITY AND JURISDICTION; proceed to next page.

2 NO, IN COMMUNITY BUT NOT UNDER OUR JURISDICTION;
Please give this questionnaire to the agency and person with emergency planning responsibilities for this facility to complete.

3 NO, NOT IN COMMUNITY.
Is the facility or company in a nearby community? (circle response)
1 Yes; if yes, which community? ________________________________
Who do we contact in that community about emergency planning for a chemical emergency? Name ________________________________
Position ________________________________
2 No; Your Community Name:
____

Please return this questionnaire in the envelope provided to:

Oak Ridge National Laboratory
PO Box X
Oak Ridge, TN 37831

Attn. John H. Sorensen, MS 206; Bldg. 4500N

INSTRUCTIONS

In some of the following questions we refer to "the facility". With respect to your community this refers to the facility identified in the cover letter. Please answer the questions only in reference to that facility. Most of the questions do not require specialized instructions. When a question does require instructions, they are provided with the question.

A. Emergency Planning

Q A-1 Does your community have an Emergency Operations Center (EOC)? (circle number of your answer)

1 YES, a permanent dedicated EOC that is maintained in operating condition.

2 YES, a permanent EOC that is also used for other purposes.

3 YES, a temporary EOC that is established when the need arises.

4 NO, an EOC does not exist.

5 OTHER ARRANGEMENT; explain ______________________________

____

Q A-2 Is there an alternative or backup EOC? (circle number)

1 YES

2 NO

Q A-3 About how many personnel (FTEs or Full time equivalents) work on emergency planning in the community?

_____ FTEs (if none, write 0)

Q A-4 About what percent of their time is devoted to chemical emergencies?

____ %

Q A-5 Does someone in the community have a formal responsibility for planning for a chemical emergency? (circle number)

1 YES

2 NO

Q A-6 Does the community have an emergency plan? (circle number)

1 YES

2 NO

Q A-7 Does it have a section on chemical emergencies? (circle number)

1 NO

2 YES; If Yes, in what year was it adopted?

19____

Q A-8 Is there a special plan or annex for this chemical facility? (circle number)

1 YES

2 NO

Q A-9 About how many emergency personnel would be available to respond to an accident at a chemical facility. (write number in each category; if none, write 0)

______ FULL TIME PAID EMERGENCY PERSONNEL (35 hours per week or more)

______ PART TIME PAID EMERGENCY PERSONNEL (less than 35 hours per week)

______ VOLUNTEER EMERGENCY PERSONNEL

______ PERSONNEL FROM NON-EMERGENCY AGENCIES OR DEPARTMENTS

______ PERSONNEL AVAILABLE FROM MUTAL AID AGREEMENTS

______ OTHER PERSONNEL; explain ____________________________

B. Communications

Q B-1 Who at the facility has primary responsibility for initially notifying the local community about an emergency at the facility? (Enter name and positions of all; if no one or if person is unknown, circle appropriate response below)

POSITION(S): NAME(S)

____

____

____

1 NO ONE

2 UNKNOWN

Q B-2 Who would notify the community if those persons were not available? (Enter name and positions of all; if no one or if person is unknown, circle appropriate response below)

POSITION(S): NAME(S)

____

____

____

1 NO ONE

2 UNKNOWN

Q B-3 Who has the designated official responsibility for receiving an alert from the chemical facility? (Enter name and positions of all; if no one or if person is unknown, circle appropriate response below)

POSITION(S): NAME(S)

____

____

____

1 NO ONE

2 UNKNOWN

Q B-4 Who would they notify if that person was not available? (Enter name and positions of all; if no one or if person is unknown, circle appropriate response below)

POSITION(S): NAME(S)

____

____

____

1 NO ONE

2 UNKNOWN

Q B-5 Are there any days of the week and times of day that it would be difficult for the community to receive an alert (either not issued or not received)? (circle number)

1 NO

2 YES ... please describe when and why: (indicate time periods by day and hours and the reasons each period presents difficulties)

____

____

____

____

____

____

Q B-6 What communication equipment would the facility use to notify the community of a chemical accident (primary and back-up)?

PRIMARY EQUIPMENT:

____

____

____

BACK-UP EQUIPMENT:

Q B-7 What procedure do you follow when the initial warning is received?

Q B-8 Please describe the communication equipment within your EOC. (such as commercial telephone; 911 telephone; dedicated telephone; automatic ring-down system; manual alarm; automatic alarm, radio; computer link; or other)

Q B-9 How often is this communications equipment routinely tested? (circle number)

1 YEARLY
2 SEMI-ANNUALY
3 MONTHLY
4 WEEKLY
5 DAILY
6 NEVER

Q B-10 Please describe any mobile communications resources available to the community.

Q B-11 What information does the community need from the chemical facility in an emergency notification to make a decision to warn the public?

____

____

____

____

____

____

Q B-12 The emergency warning system to alert and inform the public in case of a chemical emergency at the facility is primarily comprised of (circle all that apply):

1 FIXED (permanently installed) MECHANICAL SIRENS
2 FIXED ELECTRONIC SIRENS
3 FIXED HORNS, BELLS OR WHISTLES
4 FIXED LOUDSPEAKERS / PUBLIC ADDRESS
5 FIXED FLASHING LIGHTS / STROBES
6 PORTABLE LOUDSPEAKERS / PUBLIC ADDRESS
7 PORTABLE SIRENS / WHISTLES
8 NOAA WEATHER RADIO
9 EMERGENCY BROADCAST RADIO STATION
10 TONE ALERT RADIOS
11 RADIO PAGERS
12 AUTOMATED TELEPHONE DIALERS
13 OTHER; specify ______________________________

Q B-13 Is there a person in the community with the responsibility of maintaining communications with the facility during an emergency? (circle number)

1 NO
2 YES; Please indicate the name and position of all:

POSITION(S): NAME(S)

____

____

____

C. Emergency Decision Making

Q C-1 Who has the legal authority to activate an emergency warning or public alert system in your community?

POSITION(S): NAME(S)

____

____

____

Q C-2 Does anyone in the community have the assigned responsibility to make the decision to warn the public in the event of a chemical accident? (circle number)

1 NO

2 YES; same as the person(s) with legal authority in previous question

3 YES; different than the person(s) with legal authority in previous question; indicate the name and position of all:

POSITION(S): NAME(S)

____

____

____

Q C-3 Please describe the process for making the decision to warn the public after receiving an initial alert from the facility?

____

____

____

____

____

Q C-4 Many different types of emergencies can occur at a chemical facility. One type is a very fast release of hazardous materials posing a clear threat to public safety. A second type is a slowly developing problem with a potential for a release.

a. What is the minimum number of people that would have to be involved in making the decision to warn the public? (please record the total number of people playing an active role in making the decision to warn the public)

______ PEOPLE IN A FAST-MOVING EMERGENCY

______ PEOPLE IN A SLOWLY DEVELOPING EMERGENCY

Q C-5. Once you have received an initial alert from the facility about how long would it take to mobilize the necessary people that make the decision once an initial alert is received and what is the basis for your estimate? (please estimate the range as a minimum or fastest possible time and the most likely time in hours -H and minutes -M; if less than 1 hour write a 0 before the H and specify minutes only)

IN A FAST-MOVING EMERGENCY:

MINIMUM: ___ H ___ M; MOST LIKELY: ___ H ___ M;

IN A SLOWLY DEVELOPING EMERGENCY:

MINIMUM: ___ H ___ M; MOST LIKELY: ___ H ___ M;

BASIS FOR ESTIMATE:

Q C-6 Is there a written procedure for making the decision to issue a public warning? (circle number)

1 NO

2 YES; please attach a copy of the procedure

Q C-7 How long would it take to make a decision to notify the public? (please estimate the range as a minimum and most likely time in hours -H and minutes -M; if less than 1 hour write a 0 before the H and specify minutes only)

IN A FAST-MOVING EMERGENCY:

MINIMUM: ___ H ___ M; MOST LIKELY: ___ H ___ M;

IN A SLOWLY DEVELOPING EMERGENCY:

MINIMUM: ___ H ___ M; MOST LIKELY: ___ H ___ M;

Q C-8 There are a number of ways to protect the health and safety of people from a release of hazardous chemicals (protective actions).

a. What protective actions would be considered for recommendation in a chemical emergency for the general population?

b. What protective actions would be considered for recommendation in a chemical emergency for institutional facilities (such as hospitals, schools, prisons, or nursing homes)?

____

____

____

____

Q C-9 Does your community have a written procedure for making a decision about what protective actions to recommend or order? (circle number)

1 NO

2 YES; please attach a copy of the procedure

Q C-10 Does your community have a written plan or procedure for issuing an alert/warning? (circle number)

1 NO

2 YES; please attach a copy of the procedure

Q C-11 Does your community have a written warning/alert plan or procedure that is specific to the facility? (circle number)

1 NO

2 YES; please attach a copy of the procedure

Q C-12 What effort, if any, has your community made to provide the general public with information about chemical hazards and emergency response? (Please describe and attach any relevant information describing these efforts)

____

____

____

____

____

____

D. Populations at Risk

Q D-1 About what percent of the land use within one mile of the facility is in the following categories?

_______% OPEN SPACE

_______% INDUSTRIAL (wholesale; manufacturing)

_______% COMMERCIAL (retail; offices)

_______% SUBURBAN RESIDENTIAL (single family)

_______% URBAN RESIDENTIAL (multi-family)

_______% OTHER ___________________________(specify)

Q D-2 About what percent of the land use within five miles of the facility is in the following categories? ?

_______% OPEN SPACE

_______% INDUSTRIAL (wholesale; manufacturing)

_______% COMMERCIAL (retail; offices)

_______% SUBURBAN RESIDENTIAL (single family)

_______% URBAN RESIDENTIAL (multi-family)

_______% OTHER ___________________________(specify)

Q D-3 Approximately how many people live within 1 mile of the facility? (if none write 0)

_______ PEOPLE

Q D-4 Approximately how many people live within 5 miles of the facility? (if none write 0)

_______ PEOPLE

Q D-5 Are there significant fluctuations in the size of the population (such as workers, tourists, or visitors) in any of the area within 5 miles of the facility?

a. During the day or night ? (circle number)

1 NO

2 YES; please describe the circumstances, timing of the fluctuation, and number of people involved

____

____

____

____

____

____

b. During different seasons? (circle number)

1 NO

2 YES; please describe the circumstances, timing of the fluctuation, and number of people involved

____

____

____

____

____

____

c. During weekends? (circle number)

1 NO

2 YES; please describe the circumstances, timing of the fluctuation, and number of people involved

____

____

____

____

____

____

Q D-6 Are there institutional populations within 5 mile of the facility (eg. schools, hospitals, nursing homes, correctional facilities)? (circle number)

1 NO

2 YES; please list below and provide an estimate of population in each

Name of Facility	Type	Population

E. Public Alert and Warning

Q E-1 Please indicate the primary and secondary methods, if any, for warning the following populations within 5 miles of the facility. Primary methods are those systems that are most likely to be used in an emergency. Secondary methods are backup options that are currently available for use if primary methods fail. (Please read the entire list of warning options. Then place a P for primary and a S for secondary in the appropriate boxes for each population group. Leave cells blank if warning method would not be used.)

	Public within 1 mile of facility	Public 1 to 5 miles from facility	Institutional facilities within 5 miles	Transient populations
permanent sirens				
tone-alert radio				
telephone ringdown system				
fixed loudspeakers/ public address				
emergency broadcast system				
door to door				
portable sirens/ loudspeakers on vehicles				
TV/ radio				
Cable Override				
Commercial Telephone				
Two-way radio				
Air or helicopter				
Other				

Please specify other ______________________________

Q E-2 How often are the warning equipment and procedures routinely tested? (circle number)

1 YEARLY

2 SEMI-ANNUALY

3 MONTHLY

4 WEEKLY

5 DAILY

6 NEVER

Q E-3 Is there a special warning system(s) in your community for another type of hazard? (eg. civil defense outdoor sirens, nuclear power plant system, flash flood warning system; circle number)

1 NO

2 YES; please describe

____

____

____

____

____

____

Q E-4 Please estimate how long it would take to notify each population group and briefly describe the basis for that estimate (check unknown if you cannot estimate)

a. Residents within 1 mile of facility:

_____ HOURS _____ MINUTES _____ UNKNOWN

BASIS FOR ESTIMATE:

____

____

____

____

____

b. Residents 1 to 5 miles of facility:

_____ HOURS _____ MINUTES _____ UNKNOWN

BASIS FOR ESTIMATE:

c. Institutional populations listed in question D-6:

Facility Name	Warning Time		
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN

BASIS FOR ESTIMATES (include a description of who at the facility the estimate refers to; eg. an administrator or the population at the facility):

d. Fluctuating (transient) populations listed in question D-5:

Group Name	Warning Time		
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN
	____HOURS	____ MINUTES	____UNKNOWN

BASIS FOR ESTIMATE:

F. Warning Content

Q F-1 Which of the following authorities (or equivalents) would be identified in the warning as the source of the warning information ? (circle all that apply or no one)

1 MAYOR
2 COUNTY EXECUTIVE
3 CIVIL DEFENSE OR EMERGENCY OFFICIAL
4 CITY OR COUNTY MANAGER
5 PUBLIC HEALTH OFFICIAL
6 ENGINEER/SCIENTIST FROM FACILITY
7 ENGINEER/SCIENTIST FROM GOVERNMENT
8 POLICE CHIEF
9 SHERIFF
10 FIRE CHIEF
11 CHEMICAL FACILITY MANAGER
12 STATE OFFICIAL
13 NO ONE WOULD BE IDENTIFIED
14 OTHER (specify) ______________

Q F-2 Do you have a written message protocols (For example Emergency Broadcast Station or EBS messages) for communicating with the general public in an emergency? (circle number)

1 NO; please describe the information you would provide in the message.

____

____

____

____

____

2 YES; please attach a copy of the protocols

Q F-3 Do you have a written message protocols (For example Emergency Broadcast Station or EBS messages) for communicating with the institutional facilities in an emergency? (circle number)

1 NO; please describe the information you would provide in the message.

____

____

____

____

____

2 YES; please attach a copy of the protocols.

Q F-4 Do you have warning messages for non-English speaking populations? (circle number)

1 YES, for the following language(s):

____

____

2 NO, do not have non-English population(s).

3 NO, have not developed.

G. Coordination

Q G-1 How has your community's emergency organization coordinated emergency planning for a chemical accident with each of the following agencies/organizations in the past several years? (check each category that applies to each group)

Check all that apply for each Agency/Organization

	Does not apply in this community	No Contact At All	Initial/ Introductory Contact Only	Developed Emergency Response Plans With	On-going Coordinated Emergency Effort	Participate in Emergency Exercises With
1. Chemical facility	_____	_____	_____	_____	_____	_____
2. Other local agencies	_____	_____	_____	_____	_____	_____
3. Local relief (red cross)	_____	_____	_____	_____	_____	_____
4. State CD	_____	_____	_____	_____	_____	_____
5. State Police	_____	_____	_____	_____	_____	_____
6. Other communities	_____	_____	_____	_____	_____	_____
7. FEMA	_____	_____	_____	_____	_____	_____
8. Hospitals	_____	_____	_____	_____	_____	_____
9. State EPA	_____	_____	_____	_____	_____	_____
10. US EPA	_____	_____	_____	_____	_____	_____
11. Media	_____	_____	_____	_____	_____	_____

Others
(including institutions such as schools nursing homes etc.)

__________	_____	_____	_____	_____	_____	_____
__________	_____	_____	_____	_____	_____	_____

Q G-2 How many times in the last 2 years you participated in emergency exercises on chemical accidents? (if none write 0)

_____ EXERCISES

Q G-3 Has your community used information from the Chemical Manufacturers Association CAER Program (Community Awareness/Emergency Response)? (circle number)

1 YES

2 NO

Q G-4 What entity has the state designated as the Local Emergency Planning District in your area to develop an emergency plan for chemical accidents? (please describe)

____

____

Q G-5 Has the membership of this committee been appointed? (circle number)

1 NO

2 YES; if yes, how is your community represented on this committee?

____

____

____

____

Q G-6 Has the facility provided the community with information describing the hazardous chemicals used at the facility? (circle number)

1 NO

2 YES; if yes, what have they provided?

____

____

____

Q G-7 Indicate the resources that you currently have, resources you have received from the chemical facility, resources that would be available from the chemical facility, resources that you could receive from a mutual aid agreement, or resources from another source to assist you in a chemical emergency.(check all that apply)

	Currently have in community	Provided by the chemical facility	Available in an emergency from facility	Have mutual aid agreement (with another community)	Have from another source
Expertise or technical assistance	______	______	______	______	______
Fire team	______	______	______	______	______
Emergency team	______	______	______	______	______
HazMat team	______	______	______	______	______
Decontamination team	______	______	______	______	______
Medical personnel	______	______	______	______	______
Decontamination equipment	______	______	______	______	______
Monitoring equipment	______	______	______	______	______
Protective equipment	______	______	______	______	______
Other__________	______	______	______	______	______

H. COMPUTER USE

Q H-1 Does your community use a computer in emergency planning, that is, in preparing for an emergency? (circle number)

1 NO

2 YES; What is it used for ?

____

____

What type of computer?

____

____

Q H-2 Does your community use a computer in emergency management, that is, in responding to an emergency? (circle number)

1 NO (if no to both Q's H-1 and H-2, go to question 7 below)

2 YES; What is it used for ?

____

____

What type of computer?

____

____

Q H-3 How many people directly involved in emergency management in your community use computers for the each of the following activities?

WORD PROCESSING ______ PEOPLE

SPREAD SHEETS ______ PEOPLE

DATA BASE MANAGEMENT ______ PEOPLE

COMMUNICATIONS
& DATA ACCESS ______ PEOPLE

SPECIAL EMERGENCY
PLANNING FUNCTIONS ______ PEOPLE

SPECIAL EMERGENCY
MANAGEMENT FUNCTIONS ______ PEOPLE

OTHER APPLICATIONS
PLEASE SPECIFY

____________________ ______ PEOPLE

Q H-4 FOR EACH COMPUTER APPLICATION: How often do emergency personnel in the community (including yourself) use each of the following computer applications? (Circle Appropriate Number)

	1 DAILY	2 WEEKLY	3 MONTHLY	4 A FEW TIMES A YEAR	5 ONCE A YEAR OR LESS	6 NEVER
Word Processing	1	2	3	4	5	6
Data Base & Resource Management	1	2	3	4	5	6
Spread Sheet & Budgeting	1	2	3	4	5	6
Communication & Data Access	1	2	3	4	5	6
Special Emergency Planning Functions	1	2	3	4	5	6
Special Emergency Management Functions	1	2	3	4	5	6

Q H-5 If you use software designed specifically for emergency planning functions please describe the programs and their use? (circle number)

1 DO NOT USE

2 USE; please complete.

Software	Use
______________	______________________________
______________	______________________________
______________	______________________________
______________	______________________________

Q H-6 If you use software designed specifically for emergency management functions please describe the programs and their use? (circle number)

1 DO NOT USE

2 USE; please complete.

Software Use

_______________ ______________________________________

_______________ ______________________________________

_______________ ______________________________________

_______________ ______________________________________

Q H-7 Do you use a model for predicting the dispersion of chemicals? (circle number)

1 NO

2 YES; please describe the model and its uses.

____

____

____

____

I. Overall Assessment

Q I-1 What do you consider to be the weakest link in the sequence of tasks that are involved in getting a timely and effective warning to the public around the chemical facility?

____

____

____

____

____

Why?

____

____

____

____

____

Q I-2 Overall what is your assessment of the capability to provide a timely warning to the public within 5 miles of the facility in the event of a serious emergency? (circle number)

1 IT IS HIGHLY CERTAIN THAT AN EFFECTIVE WARNING WOULD BE MADE

2 IT IS SOMEWHAT CERTAIN THAT AN EFFECTIVE WARNING WOULD BE MADE

3 IT IS SOMEWHAT UNCERTAIN THAT AN EFFECTIVE WARNING WOULD BE MADE

4 IT IS HIGHLY UNCERTAIN THAT AN EFFECTIVE WARNING WOULD BE MADE

Q I-3 Are there other facilities in your community that require emergency plans because they have hazardous chemicals? (circle number)

1 NO; skip to question 6

2 YES; if yes, about how many facilities?

_____ FACILITIES IN THE COMMUNITY

Q I-4 On the whole how do the emergency planning efforts of the facility identified in the cover letter compare to the other chemical facilities in your community? (circle number)

1 MUCH BETTER THAN OTHERS

2 SOMEWHAT BETTER THAN OTHERS

3 ABOUT THE SAME AS OTHERS

4 SOMEWHAT POORER THAN OTHERS

5 MUCH POORER THAN OTHERS

Q I-5 If an emergency occurred at the facility how does the community's ability to issue a timely warning to the public around the facility compare with the ability to issue a warning around other facilities? (circle number)

1 SIGNIFICANTLY BETTER THAN FOR OTHERS

2 SLIGHTLY BETTER THAN FOR OTHERS

3 ABOUT THE SAME AS FOR OTHERS

4 SLIGHTLY POORER THAN FOR OTHERS

5 SIGNIFICANTLY POORER THAN FOR OTHERS

Q I-6 The following are areas in which the acquisition of new resources or improvements of existing capabilities could enhance preparedness for chemical emergencies in your community. If you could obtain these over the next several years which would you want first, second, third and so forth? Please rank these areas in the order which you feel they are needed by your community. (Please read the entire list. Place a 1 by the area that is needed first Next place a 2 by the area needed second. Continue until all areas are ranked.)

____ COMMUNICATIONS EQUIPMENT
____ COMPUTER WITH EMERGENCY MANAGEMENT SYSTEM
____ DECONTAMINATION EQUIPMENT
____ FUNDING FOR A PLANNER
____ FUNDING FOR SENDING STAFF TO TRAINING
____ FUNDING TO PREPARE AN EMERGENCY PLAN
____ MEDICAL EQUIPMENT
____ MONITORING EQUIPMENT
____ PROTECTIVE CLOTHING
____ PUBLIC ALERT/WARNING EQUIPMENT
____ RESPIRATORY PROTECTION EQUIPMENT

Q I-7 Advances in knowledge and technology can improve the basis for emergency preparedness. The following are areas in which improvements could enhance preparedness for chemical emergencies. If you could obtain these over the next several years which would you want first, second, third and so forth? Please rank these areas in the order which you feel they are needed by your community. (Please read the entire list. Place a 1 by the area that is needed first Next place a 2 by the area needed second. Continue until all areas are ranked.)

____ IMPROVE COMMUNICATIONS TECHNOLOGIES
____ IMPROVE COMPUTERIZED DISPERSION MODELS
____ IMPROVE DECISION SUPPORT SYSTEMS
____ IMPROVE INFORMATION HOT-LINES
____ IMPROVE KNOWLEDGE ON PROTECTIVE ACTION EFFECTIVENESS
____ IMPROVE KNOWLEDGE ON THE TOXICITY OF CHEMICALS
____ IMPROVE MONITORING TECHNOLOGIES
____ IMPROVE PROTECTIVE EQUIPMENT
____ IMPROVE PUBLIC ALERT/WARNING TECHNOLOGIES
____ IMPROVE TECHNICAL PLANNING GUIDES
____ IMPROVE TRAINING PROGRAMS/COURSES

Q I-8 Has any emergency occurred in the last 5 years that has resulted in a public warning in your community?

1 NO

2 YES; please briefly describe the incident(s) and how the public were warned

____

____

____

____

____

____

____

____

How many people in total assisted in answering this questionnaire?

_______ PEOPLE

About how long did it take to complete?

________ HOURS

Who in the community can we contact for additional information if necessary?

NAME:

ADDRESS:

PHONE:

Have you included the following plans, procedures, and protocols including:

Decision making procedures for public warning decision (Q C-5)

Decision making procedures for selecting protective actions (Q C-13)

Written warning/alert plan and procedures (Q C-14)

Warning/alert plan and procedures for facility (Q C-15)

Warning message protocols (Q F-2 and F-3)

Appendix 14
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