THE CHEMICAL SAFETY AUDIT PROGRAM:

FY 1998 STATUS REPORT

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EXECUTIVE SUMMARY

This is a comprehensive report on the status of the U.S. Environmental Protection Agency's Chemical Emergency Preparedness and Prevention Office's (CEPPO) Chemical Safety Audit (CSA) program since its inception in fiscal year (FY) 89, a review of the successful and problematic trends of CSA program implementation in FY 98, and a discussion of the current and future role of the CSA program in the CEPPO Prevention Strategy.

In these ten years, the CSA program has encompassed the review of the chemical process safety management systems of 372 facilities and the training of over 1100 federal, state, and local officials. In addition, the CSA program has developed a database of chemical safety audit information and supported numerous other related chemical accident prevention activities, including outreach and technical assistance for both the public and private sector.

Chemical accident prevention involves identifying the causes of accidental releases of hazardous substances and the means to prevent them from occurring, promoting industry initiatives in these areas, and sharing the results with the community, industry, and other interested groups. EPA established the CSA program to:

- Heighten awareness of and promote chemical safety among facilities handling hazardous substances, as well as in communities where chemicals are located;
- Build cooperation among facilities, EPA, and others by conducting joint audits;
- Gather information on safety practices and technologies from facilities handling hazardous substances; and
- Establish a database for the assembly and distribution of chemical process safety management information obtained from the facility audits.

The CSA program is not a compliance or regulatory program; however, EPA does have legal authority for entering a facility and conducting a chemical safety audit under sections 104(b) and 104(e) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The audit consists of interviews with facility personnel and an on-site review of various aspects of facility operations related to the prevention of accidental chemical releases. Observations and conclusions from the audit are detailed in a report, available to the public, that identifies both problematic and successful chemical process safety management practices, as well as technologies for preventing and mitigating chemical releases.

This status report is intended to provide EPA headquarters and regional management with a better understanding of how the program is being implemented both at headquarters and in the regions, the purpose and goals of the audit program, and the type of information being generated and its uses. The following four topics are the focus of this report — program activities, program results, regional program implementation, and analysis of audit results.

Regional Implementation Status

In addition, the CSA program has provided the opportunity for greater cooperation and communication with state and local officials as a result of their participation in the audit process and associated training and outreach activities. State and local audit participants stress the beneficial aspects of the program from increased government-industry coordination to enhanced understanding of chemical process safety issues in the community. In addition, as the CSA program has developed, the regional offices have initiated new programs and activities and introduced modifications to audit procedures that take advantage of the program's flexibility. Initiatives such as mini-audit programs and accident investigations, as well as greater pre-audit planning, coordination with other environmental and health and safety programs, and outreach to industry, have also been the products of the evolution of the CSA program. For example, in FY 98, Region 3 conducted 58 mini-audits and Region 8 conducted 24 mini-audits of water treatment operations, ammonia refrigeration systems, and other facilities with toxic and flammable chemicals.

Program Activities/Results

The achievements of the audit program, outlined in Chapter 2, are based on the number of full-scale audits conducted and reports completed in each region, along with a summary of the audits by the facility's Standard Industrial Classification (SIC) code and by the hazardous substances examined during the audit. An overview of participation in training workshops offered by EPA headquarters is also included.

As of the close of FY 98, the regions had submitted a total of 363 final reports to EPA. Information from the 14 most recently submitted reports was examined for this status report, including a number of reports from audits conducted in FY 97 that were not submitted to EPA headquarters in time to be included in the FY 97 Status Report.

CEPPO has designed a four-day chemical safety audit workshop that gives potential audit team members the training to conduct an audit; beginning in FY 93, these courses have been presented by EPA's Environmental Response Team as part of their training curriculum. From 1989 through 1998, a total of 68 workshops, attended by over 1700 individuals throughout all ten regions, have been conducted; 179 individuals attended the eight workshops held in FY 98. The most noteworthy trend in these workshops has been the increased involvement of state and local officials, who account for approximately 51 percent of the overall attendance, but 73 percent of the attendees in the past year. This represents a concerted effort within the CSA program to increase awareness and participation by these individuals in combination with increasing state and local interest in chemical process safety issues. In addition, with the applicability of the new Risk Management Program regulations to operations at federal facilities, 13 percent of workshop attendees during FY 98 were federal officials and their contractors.

To realize the goals of the CSA program to collect and disseminate information on chemical process safety issues and to improve program coordination, CEPPO has assembled a computerized database to provide EPA regions and headquarters (as well as state and local government agencies) with information gathered from chemical safety audit reports in a format consistent with the CSA protocol. Through analysis of the database, the user can identify successful and problematic techniques or practices employed to manage process safety at facilities handling hazardous substances. The database is

being used by CEPPO to develop guidance and technical assistance documents that will be distributed to individuals and organizations involved in chemical accident prevention. In addition, the database has been given to federal, state, and local officials attending the training workshops, who use the audit report information to increase their familiarity with chemical process safety issues and to support their own inspection and auditing activities.

FY 98 Audit Analysis

Chapter 3 presents an overview of conclusions and recommendations taken from recent EPA chemical safety audits, based on the latest 14 final CSA reports received by EPA headquarters as of September 30, 1998. Once again, the results have been organized according to the major elements of generally accepted chemical process safety management practices, which form the basis for the facility risk management programs specified under Clean Air Act (CAA) section 112(r). Seventeen major chemical process safety elements are examined in this chapter: corporate and facility management, process hazard analysis (hazard evaluation), offsite consequence analysis, process safety information, standard operating procedures, equipment and instrument maintenance, training, safety audits, accident investigation, management of change, pre-startup review, hot work permits, employee participation, contractors, release prevention and mitigation measures, facility emergency preparedness and response, and community emergency response coordination.

Each section of Chapter 3 reviews the key features in the implementation of one of these chemical process safety elements, as well as the role each element plays in maintaining a safe facility. After an overview of general trends in audit team observations and conclusions from the last several years, each section highlights notable facility practices taken from the latest 14 audit reports. For example, most of the audited facilities have developed procedures for conducting investigations of certain accidental releases of hazardous substances. However, the audit teams visiting these facilities noted very significant differences in the range of releases that were investigated, the scope of the investigation, the process of implementing corrective action and follow-up procedures.

Conclusion

EPA views the CSA program as an integral component of its overall chemical safety program and an ongoing means of stimulating chemical accident prevention initiatives. The voluntary nature of the audits encourages facilities to work with EPA and allows industry to feel comfortable in sharing their audit experiences and recommendations with other industry partners. Another important factor is the close coordination of resources and focus at the regional level with other CEPPO prevention efforts. Current benefits from the CSA program include the following:

- CSA training workshops and audit participation provide EPA, state emergency response commissions (SERCs), local emergency planning committees (LEPCs), and other federal agencies with a better understanding of chemical process safety management and facility practices to prevent and mitigate chemical releases;

- Audit activities foster a more cooperative attitude between government and industry on chemical process safety issues; and

- Jointly conducted audits and training support cooperation and coordination on chemical safety programs among federal, state, and local government agencies.

On May 24, 1996, EPA's Administrator signed the final rule for the risk management planning requirements mandated under Clean Air Act (CAA) section 112(r). The rule requires certain facilities ("sources") handling regulated substances in a process above specific quantities to develop and implement a risk management program consisting of a hazard assessment, a prevention program, and an emergency response program. Sources will summarize their risk management program in a risk management plan (RMP), which will be made available electronically to state and local government and the public. Sources with processes covered by the RMP rule must have complied with these requirements by June 21, 1999. EPA and the other agencies responsible for implementing these regulations are required to conduct audits of RMPs and will also conduct site inspections to oversee and enforce compliance with the rule by evaluating actual practices.

Thus, chemical accident prevention practices, which the CSA program encourages, are now mandatory for certain processes at sources covered by the RMP rule. EPA is encouraging state governments to take responsibility for implementing the RMP program, and several states have indicated that they will apply for delegation of the program. The CSA program will continue to play a key role in assisting these states with guidance, training, and technical assistance on chemical process safety issues and the audit process. Although the number of chemical safety audits has declined in the last four years, training workshop attendance has remained strong and increased in many states. In addition, analysis of CSA program results across industry sectors will give RMP auditors and inspectors a basis on which to evaluate the efficacy of facility chemical safety policies and practices.

In addition, it is expected that CSA team members will be involved in implementation of these regulations at the regional level (for facilities in states that do not take delegation of the program) by providing compliance assistance, auditing facility RMPs, and inspecting facility risk management programs. RMP auditors and site inspectors will be able to draw on their CSA training and experience in selecting, planning, and conducting site visits. At the same time, there will still be many facilities handling extremely hazardous substances that are either not included on the RMP list, or below threshold quantities, or in concentrations that are not covered by the RMP requirements. Even at large facilities with processes covered by RMP, often there will be many additional processes taking place that use hazardous substances which are not covered by RMP. Thus, the CSA program will continue to have an important role in accident prevention through audits of these facilities.

The CSA program, the Risk Management Program, and the Clean Air Act General Duty Clause are components of EPA’s integrated chemical safety program. Depending on the circumstances at a particular facility, EPA may choose to apply one or more of these elements to achieve greater protection of human health and the environment.

1.0 CHEMICAL SAFETY AUDIT PROGRAM: HISTORY AND FUTURE

In the ten years since EPA initiated the Chemical Safety Audit (CSA) program in 1988, over 372 full-scale chemical safety audits and approximately 180 mini-audits have been conducted by EPA regional offices. In addition, an extensive training program has been established and a CSA program database has been developed. The CSA program also has prompted a growing interest among state and local officials in the audit process and in the underlying concepts of chemical process safety management. With the publication of the final risk management planning regulations mandated under section 112(r) of the Clean Air Act (CAA), the CSA program has assumed a critical support role in the development of the national chemical accident prevention effort spearheaded by EPA's Chemical Emergency Preparedness and Prevention Office (CEPPO).

For the 372 full-scale chemical safety audits conducted over the ten years ending September 30, 1998, 363 final audit reports have been prepared (see Appendix B). To compile information for this report, the final audit reports have been summarized in a standard format consistent with the CSA protocol. These profiles present a summary of audit observations and include the audit team's conclusions and recommendations. The profiles also contain information on facility name, location, primary processes, and product(s); the hazardous substances examined for the audit; and the name, affiliation, role, and expertise of each audit team member.

The remainder of this chapter describes the future of the CSA program and the primary features of the existing CSA program, including its history and purpose, and key program activities — CSA training workshops and the CSA database. Chapter 2 presents a statistical overview of the results of CSA program activities and achievements. Lastly, Chapter 3 reviews facility chemical process safety practices identified in the final CSA reports submitted to CEPPO since the publication of the FY 97 CSA Status Report.

1.1 Program Background

History

The CSA program is part of a broad EPA initiative designed to accomplish four chemical accident prevention goals:

- Learn about and understand problematic and successful practices and technologies for preventing and mitigating releases from facilities handling hazardous substances;
- Heighten awareness of chemical safety among chemical producers, distributors, and users, as well as in communities where chemicals are located;
- Build cooperation among authorized parties by coordinating joint audits where appropriate; and
- Establish a database for the assembly and distribution of chemical safety information obtained from facility audits and from other sources.

Following the 1984 release of methyl isocyanate in Bhopal, India, and subsequent incidents in the United States, awareness of the threat to public safety posed by similar incidents led to an emphasis on preparedness and planning for response to chemical accidents. EPA established the Chemical Emergency Preparedness Program to help states and communities plan for chemical emergencies. Many of the features of this voluntary program were incorporated into SARA Title III, which establishes a chemical emergency preparedness infrastructure within each state, territory, and Tribal land.

Recognizing accident prevention as the next step after instituting local emergency preparedness efforts, EPA sought to identify causes of accidental releases of hazardous substances and the means to prevent them from occurring, to promote accident prevention practices in industry, and to share information with the community, industry, and other groups (e.g., academia, professional organizations, trade associations, labor, and environmental groups). Many of these key concerns were identified in the Congressionally mandated SARA Title III section 305(b) study, *Review of Emergency Systems*. This study reviewed technologies, techniques, and practices for preventing, detecting, and monitoring releases of extremely hazardous substances, and for alerting the public to such releases. As part of the information-gathering needed to prepare this study, a number of facility audits were conducted to evaluate, first-hand, their chemical process safety management practices. As one method of acquiring additional information and encouraging awareness of accident prevention at facilities, the study recommended that EPA continue the program of facility audits, thus inaugurating the CSA program.

Authority

While the CSA program is not a compliance or regulatory program, EPA does have legal authorities for entering a facility and conducting a chemical safety audit. The primary authority for EPA and its designated representatives to enter a facility and review its records and operations is contained in CERCLA sections 104(b) and 104(e). The audits are intended to be non-confrontational and positive, so that information on safety practices, techniques, and technologies can be identified and shared between EPA and the facility. If serious problems are discovered during the audit, however, EPA may use a variety of legal authorities to address them.

Audit Team

An EPA audit team consists primarily of EPA employees and other designated representatives, including contractors and AARP members. Other federal, state, and local government personnel, particularly representatives of State Emergency Response Commissions (SERCs) and Local Emergency Planning Committee (LEPCs) established under EPCRA, are encouraged to participate in audits as team members or observers. The audit team can vary in size depending on the scope of the audit and the expertise of individual team members. Although states and local governments must use their own authorities for audit participation, the CSA program encourages the involvement of LEPC and SERC members throughout the audit process.

Audit Selection

In selecting a facility for a chemical safety audit, the EPA regional office may consider a number of factors, including but not limited to the hazardous substances used, the facility's history of releases, the facility's proximity to a sensitive population or area of high population density, its accident prevention

technologies, or the industry's concentration in the area. The regional office may review federal, state, and local release notification reports and follow-up reports; On-Scene Coordinator (OSC) reports; Regional Response Centers; Accidental Release Information Program (ARIP) reports; and other sources. Currently, most facilities selected have been identified based on their history of accidental releases, using ARIP, the Emergency Response Notification System (ERNS), and other release information sources.

At present, EPA regional offices are not required to follow any formal procedures when selecting a facility for an audit, as long as the following two important requirements are met:

- Under CERCLA, EPA may enter a facility only if a release of a CERCLA hazardous substance, pollutant, or contaminant has occurred at the facility, or there is "reason to believe" that a threat of such a release exists; and

- The Office of the Regional Counsel and the SERC must be consulted to identify any legal actions currently being pursued or anticipated against the audited facility. Although not compliance-oriented, a chemical safety audit conducted at a facility where legal action is on-going or anticipated may interrupt or otherwise have an impact on the settlement process. It is also suggested that other regional program offices be consulted.

EPA can, of course, enter a facility and conduct an audit at the invitation or with the voluntary consent of the facility's management.

Audit Process

The audit consists of interviews with facility personnel and on-site review of various aspects of facility operations related to the prevention of accidental chemical releases. Observations and conclusions from the audits are detailed in a report prepared by the audit team. The report identifies and characterizes the strengths and weaknesses of specific chemical accident prevention program areas to allow the elements of particularly effective programs to be recognized and to share information on problematic practices. Copies of the report are given to the facility and its corporate management so that weak and strong program areas may be recognized.

The audit is conducted in accordance with the *Guidance Manual for EPA Chemical Safety Audit Team Members*, which contains mandatory procedures, as well as recommended actions, to follow to ensure the health and safety of program auditors and program integrity. Each member of the audit team should have a copy of the manual, and a copy of the manual should be sent to the facility prior to the audit. The guidance manual also contains an audit protocol (see Appendix A), a detailed outline that directs the scope and content of the audit and establishes a structure for preparing the audit report. The protocol is designed to provide CSA teams with an organized and detailed format for conducting an audit and preparing a comprehensive report. By following the protocol in preparing CSA reports, regional staff ensure continuity and consistency in report preparation.

1.2 Relationship to the CEPPO Prevention Strategy

The CSA program is one component of CEPPO's overall chemical accident prevention strategy. The key to the success of the CSA program in supporting accident prevention is the cooperation built between industry and EPA through the voluntary audit participation. The voluntary nature of the audits encourages facilities to work with EPA and allows industry to feel comfortable in sharing their audit

experiences and recommendations with other industry partners. Another important factor is the ongoing coordination of the CSA program with other CEPPO prevention efforts including the Accidental Release Information Program (ARIP), the Risk Management Plan (RMP) program, and the chemical accident investigation (CAI) program:

- In 1986, the ARIP program began to collect accident information through surveys issued to certain facilities experiencing accidental releases. The ARIP database, consisting of information taken from the ARIP survey, is used to identify candidate facilities for chemical safety audits and other prevention-related outreach programs.

- With the passage of the Clean Air Act Amendments of 1990, EPA began development of the RMP rule, in part using the information provided by ARIP and CSA. Since promulgating the RMP rule in 1996, CEPPO has been working to implement the RMP program. Regional chemical safety audit team members are involved in all the facets of the RMP program, including assisting CEPPO in developing guidance documents, providing assistance to personnel from state and local implementing agencies, and working directly to help facilities understand the requirements.

- EPA's statutory responsibility for the prevention and mitigation of accidental releases necessitates action by the Agency to investigate and understand the chemical accidents that occur. These investigations, conducted by EPA's Chemical Accident Investigation Team (CAIT), may lead to issuance of new guidance or regulations relating to accident prevention. Chemical safety audit team members provide critical support to the CAIT. Team members are involved in conducting accident investigations; developing safety alerts where an unrecognized hazard is identified; and developing reports on the facts, circumstances, and root causes of accidents.

The regional offices have substantial flexibility in implementing the CSA program. The regions have used this flexibility to model the CSA program into a vehicle for meeting regional priorities for accident prevention. Specific features of the CSA program (e.g., followup activities) have served as the basis for the development of new regional initiatives. In addition, several regions have begun separate chemical-specific initiatives to address commonly used hazardous chemicals that pose the greatest risk in an accident, such as mini-audits.

FY 98, Region 3 conducted 58 "mini" chemical safety audits and Region 8 conducted 24 "mini" audits. By performing "mini" audits, the regions were able to reach a larger number of facilities at a reduced cost to the government. In general, these audits focused on smaller facilities or a specific operation at larger facility, including two dozen visits to water treatment plants using chlorine and sulfur dioxide, two dozen visits to food processors and cold storage facilities with ammonia refrigeration systems, as well as a variety of other operations involving toxic and flammable chemicals, such as propane distributors. Following their site visit, Region 3 sent a followup letter to the facility highlighting notable practices and recommendations for potential improvements.

1.3 Future Role of the CSA Program

On May 24, 1996, EPA's Administrator signed the final rule for the risk management planning requirements mandated under Clean Air Act (CAA) section 112(r). The rule requires certain facilities ("sources") handling regulated substances in a process above specific quantities to develop and implement a risk management program consisting of a hazard assessment, a prevention program, and an emergency response program. Sources will summarize their risk management program in a risk management plan (RMP), which will be made available electronically to state and local government and the public. Sources with processes covered by the RMP rule must have complied with these requirements by June 21, 1999. EPA and the other agencies responsible for implementing these regulations are required to conduct audits of RMPs and will also conduct site inspections to oversee and enforce compliance with the rule by evaluating actual practices.

Thus, chemical accident prevention practices, which the CSA program encourages, are mandatory for certain processes at facilities covered by the RMP rule. EPA is encouraging state governments to take responsibility for implementing the RMP program, and several states have indicated that they will apply for delegation of the program. The CSA program will continue to play a key role in assisting these states with guidance, training, and technical assistance on chemical process safety issues and the audit process. Although the number of chemical safety audits has declined in the last three years, training workshop attendance has remained strong and increased in many states. In addition, analysis of CSA program results across industry sectors will give RMP auditors and inspectors a basis on which to evaluate the efficacy of facility chemical safety policies and practices.

In addition, it is expected that CSA team members will be involved in implementation of these regulations at the regional level (for facilities in states that do not take delegation of the program) by providing compliance assistance, auditing facility RMPs, and inspecting facility risk management programs. Voluntary compliance assistance (with EPA and OSHA rules, in particular) has always been a component of chemical safety audits, and RMP auditors and site inspectors will be able to draw on their CSA training and experience in interacting with these facilities.

However, it is important to recognize that there will still be many facilities handling hazardous substances and not covered by the RMP rule. The RMP rule applies to only 77 toxics and 63 flammables. The list of chemicals is further curbed by various exemptions. Among the toxics, hydrochloric acid with less than 37% HCl is exempt; so are hydrofluoric acid with less than 50% HF, nitric acid with less than 80% HNO_3, and ammonia solutions with less than 20% NH_3. When in a mixture, if the concentration of the toxic is less than 1%, it is also exempt. Ammonia of any concentration used by farmers as a fertilizer is also exempted.

For the flammables, the US Court of Appeals has placed a stay for LP gas, principally propane at any threshold. The EPA Administrator has issued an administrative stay for all flammable hydrocarbons no greater than 67,000 pounds. There are two bills in Congress that would exempt all flammable fuels and liquefied petroleum from the RMP rule.

When the short list of substances is taken with the exemptions and stays, the number of facilities and processes that will be affected becomes fairly limited when compared with other environmental regulations such as EPCRA and CERCLA. Even at large facilities with processes covered by RMP,

often there will be many additional processes that use hazardous substances which are not covered by RMP. As such, the Chemical Safety Audit program will continue to have an important role in accident prevention through audits of facilities.

1.4 CSA Training Workshop

To provide guidance on the procedural and technical aspects of conducting an audit and to promote a better understanding of the objectives of the CSA program, EPA designed the Chemical Safety Audit program workshop. In FY 98, eight workshops were held in six regions. Training workshops were held in Boston, MA; Cheektowaga, NY; Philadelphia, PA; Louisville, KY; Jacksonville, FL; Springfield, IL; Little Rock, AR; and Kansas City, KS. A total of 179 attendees participated. A variety of groups was represented at the workshops including 13 regional personnel, 76 state officials, 54 local officials, and 8 representatives from other federal agencies, including staff from the U.S. Department of Labor, the U.S. Department of Defense, the U.S. Veterans Administration, the Federal Emergency Management Agency, the Army Corps of Engineers, and officials from the U.S. Navy.

For FY 99, the Environmental Response Training Program plans to present 11 additional four-day CSA courses. These workshops are designed for presentation to a combination of regional, AARP, contractor, and state and local government personnel who are or will be involved in conducting chemical safety audits. The topics addressed during the current four-day workshop include:

- Chemical process hazards
- Process safety management
- Computer modeling
- Process safety: equipment
- Process safety: operations
- Hazard and release mitigation
- Maintenance procedures and training requirements
- Conducting interviews
- Incident investigation
- Hazard evaluation
- Hazard evaluation techniques
- Emergency response
- Process inspection techniques

- Audit report writing
- *Guidance Manual for EPA Chemical Safety Audit Team Members*
- *Chemical Safety Audit Program Resource Guide*

In addition, a series of sequential group exercises is held during the workshop to provide participants with the opportunity to apply theoretical knowledge to scenarios that simulate all phases of conducting a chemical safety audit, including interviewing facility personnel.

1.5 CSA Database

To collect and disseminate information on chemical process safety issues and improve program coordination, CEPPO has assembled a computerized database to provide EPA regions and headquarters (as well as state and local government agencies) with information gathered from chemical safety audit reports in a format consistent with the CSA protocol. The profiles present a summary of audit observations and include the audit team's conclusions and recommendations. The profiles also contain information on facility name, location, primary processes, and product(s); the hazardous substances examined for the audit; and the name, affiliation, role, and expertise of each audit team member. The information in the database is useful to EPA regional offices for a variety of purposes, such as identifying field experts and comparing processes and safety practices at different facilities for the same chemicals. Although the database is not directly available to the public and industry, EPA will use it to develop guidance and technical assistance documents that will be distributed to individuals and organizations involved in chemical accident prevention.

The database has been given to interested federal, state, and local officials who have attended CSA training workshops. These individuals are using the database as a source of background information on chemical hazards, process hazards, and successful and problematic facility practices in preparation for their own inspection and auditing activities. For example, by reviewing the information on typical operating hazards and release prevention practices at the paper mills contained in the CSA database, these officials have been better prepared to conduct inspections of similar paper mills under their own jurisdiction.

The CSA database makes it possible to examine audit information about specific facilities quickly. For example, the database user can easily examine and compare audit observations and recommendations for facilities that use similar chemicals, that manufacture similar products, or that are located in the same EPA region. Users can search the database for different types of information, such as chemical names or Chemical Abstract Service (CAS) numbers, SIC codes, processes, and process safety practice or technique, or a combination of fields. For example, a user could search the database to identify the type of containment systems present at chemical manufacturing facilities (SIC code 28) that use chlorine. EPA regional and headquarters personnel (as well as other federal and state and local officials implementing similar programs) can also use the database to:

- Identify field experts for auditing advice or participation in an audit;
- Identify facilities with similar processes or practices to support an ongoing audit;

- Compare successful or problematic safety practices among similar facilities;
- Identify previous recommendations for a similar process safety practice or technique;
- Compare safety equipment among similar facilities; and
- Assemble information on a specific chemical safety process management practice.

The current version of the CSA database, distributed in July 1996, contains profiles of 312 chemical safety audits.

2.0 OVERVIEW OF CSA PROGRAM RESULTS

This chapter presents an overall summary of the achievements of the Chemical Safety Audit program focusing on the following subjects:

- Chemical safety audits and audit reports completed in each fiscal year;
- Breakdown of the audited facilities by Standard Industrial Classification (SIC) code;
- Hazardous substances examined by the audit teams; and
- Chemical safety audit training workshops conducted.

2.1 Chemical Safety Audits and Reports Completed

As of the close of FY 98, the regional offices have finalized a total of 363 audit reports for the 372 full-scale chemical safety audits, including several follow-up audits for which no audit report profile was prepared. Exhibit 1 displays totals for the number of chemical safety audits that the regional offices conducted during each fiscal year. The number of reports completed by each regional office is also included. The chart indicates that 32 full-scale chemical safety audits were completed in FY 89, 39 in FY 90, 53 in FY 91, 41 in FY 92, 57 in FY 93, 57 in FY 94, 44 in FY 95, 27 in FY 96, 13 in FY 97, and 9 in FY 98. Exhibit 2 summarizes the chemical safety audits and final reports completed by region. In addition, note that these totals do not include the mini-audits conducted by the regional offices in the last three years; in FY 98, Region 3 conducted 58 mini-audits and Region 8 conducted 24 mini-audits.

2.2 Chemical Safety Audits by SIC Code

Approximately half of the chemical safety audits conducted by the regional offices involved chemical manufacturing operations (SIC code 28). Exhibit 3 presents a breakdown by SIC code of the 363 audited facilities for which this information is available. (Some facilities' operations are categorized in more than one SIC code, a characteristic that is reflected in the exhibit.) Within SIC code 28, the vast majority of the processes examined were further classified under SIC codes 281, 282, 286, and 287. Other manufacturing operations at which a number of audits were conducted are paper and pulp mills — SIC code 26 (29), petroleum refineries — SIC code 29 (26), food processors — SIC code 20 (25), primary metal manufacturing — SIC code 33 (15), and electronic and electrical equipment manufacturing — SIC code 36 (15).

Non-manufacturing operations at audited facilities comprise one-seventh of the total number of audits and are classified in a variety of SIC codes. The major categories among these operations are nondurable goods wholesalers handling hazardous substances — SIC code 51 (22); electric, gas, and sanitary services — SIC code 49 (10); and public water treatment facilities — SIC code 95 (8).

Exhibit 1
Number of Chemical Safety Audits and Chemical Safety Audit Reports by Year and by Region
FY 89 through FY 98

Region	FY89 Audits	FY90 Audits	FY91 Audits	FY92 Audits	FY93 Audits	FY94 Audits	FY95 Audits	FY96 Audits	FY97 Audits	FY98 Audits	Total Audits	Final Reports
1	4	4	3	3	3	3	0	0	0	0	20	20
2	2	4	3	3	4	3	2	4	4	0	29	26
3	4	4	4	5	6	6	4	2	0	0	35	35
4	5	5	15	6	10	8	8	6	5	5	73	72
5	3	5	3	3	4	4	4	3	0	0	29	24
6	4	5	5	4	4	4	4	0	0	0	30	30
7	0	0	4	6	14	18	14	4	4	4	68	68
8	3	4	6	4	5	4	3	0	0	0	29	29
9	4	4	4	4	3	3	1	3	0	0	26	26
10	3	4	6	3	4	4	4	5	0	0	33	33
Total	32	39	53	41	57	57	44	27	13	9	372	363

Note: These totals do not include regional chemical accident investigations and mini-audits

Exhibit 2
Summary of Chemical Safety Audits and Final Reports Completed by Region
FY 89 through FY 98

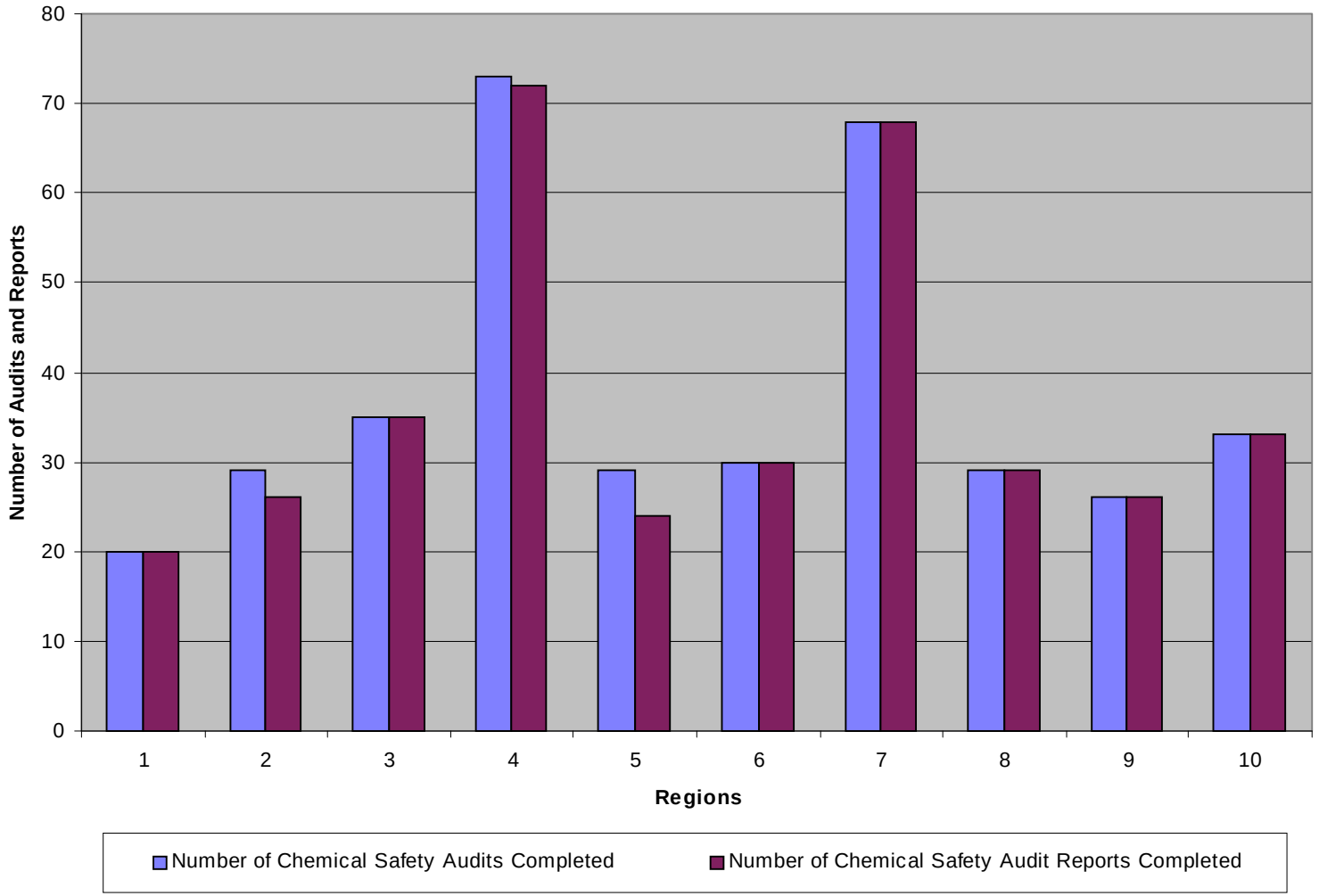
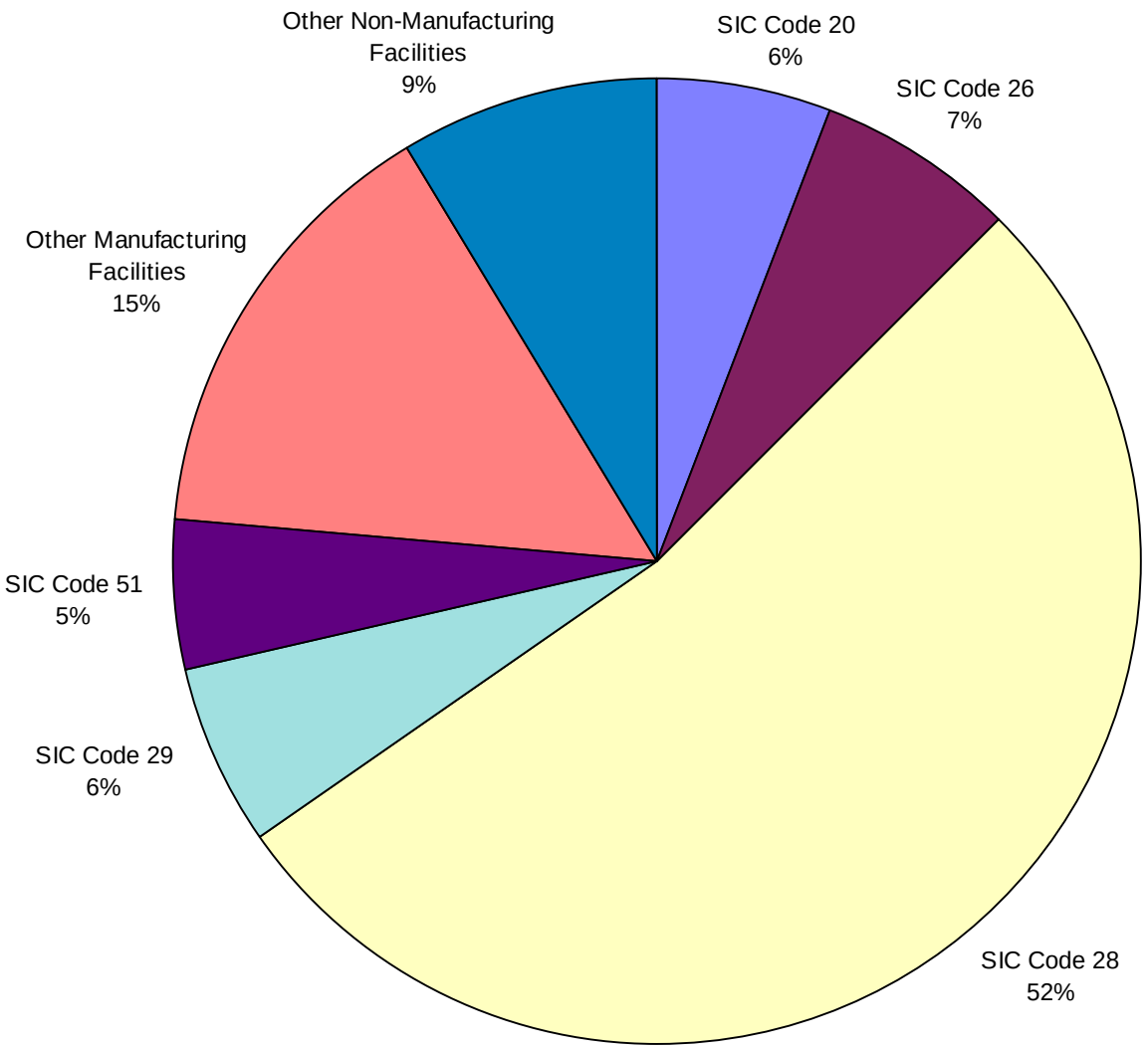


Exhibit 3
Breakdown of Audited Facilities by SIC Code
FY 89 through FY 98



2.3 Chemical Safety Audits by Hazardous Substance

A total of 194 different hazardous substances were examined by audit teams at the 339 audited facilities for which this information was available, including 172 classified as CERCLA hazardous substances and 77 listed as EPCRA extremely hazardous substances. Exhibit 4 presents a breakdown of the CERCLA hazardous substances and EPCRA extremely hazardous substances examined during the audits. On average, processes involving four hazardous and/or extremely hazardous substances were examined at each facility. The five most commonly examined substances were chlorine (131 audits), sulfuric acid (125), sodium hydroxide (105), ammonia (102), and hydrochloric acid (85).

2.4 CSA Training Workshops

As of the close of FY 98, 68 CSA workshops had been conducted in the EPA regions. Since FY 90, the host regions have been co-sponsors of the CSA workshops and provided valuable assistance in organizing and conducting the workshops. Hosting the workshop in cities near the locations of the regional office has allowed other EPA program offices and other federal agencies to attend. In addition, for the last seven years the regional offices have been coordinating with the states to identify workshop locations to encourage attendance by state and local officials.

This year, eight workshops were held in seven regions. Training workshops were held in Boston, MA (Region 1); Cheektowaga, NY (Region 2); Philadelphia, PA (Region 3); Louisville, KY (Region 4); Jacksonville, FL (Region 4); Springfield, IL (Region 5); Little Rock, AR (Region 6); and Kansas City, KS (Region 7). A total of 179 attendees participated in the eight workshops. A variety of groups was represented at the workshops including 13 regional personnel, 76 state officials, 54 local officials, and 8 representatives from other federal agencies, including staff from the U.S. Department of Labor, the U.S. Department of Defense, the U.S. Veterans Administration, the Federal Emergency Management Agency, the Army Corps of Engineers, and officials from the U.S. Navy. Exhibit 5 presents a breakdown of CSA workshop attendees by affiliation. Since FY 93, there has been a concerted effort within the CSA program to increase awareness and participation by state and local government representatives in the program. As is demonstrated in Exhibit 6, which compares the percentage of attendees by affiliation from FY 89 to FY 97 to that in FY 98, 73 percent of the FY 98 attendees represented state, local, and tribal governments, as compared to 50 percent in the previous years.

Exhibit 7 is a breakdown by region of the number of audit team members who have received training. State and local officials, EPA headquarters personnel, EPA headquarters contractors, industry and academia, and other federal agency representatives are not included in these figures. The largest number of personnel attending a workshop were from Region 4 (87), Region 3 (72), and Region 2 (58). Note that this exhibit does not include data for TAT workshop attendance since FY 94 because the technical assistance team contractors now support multiple regional offices.

Exhibit 4
Hazardous Substances Examined
FY 89 through FY 98

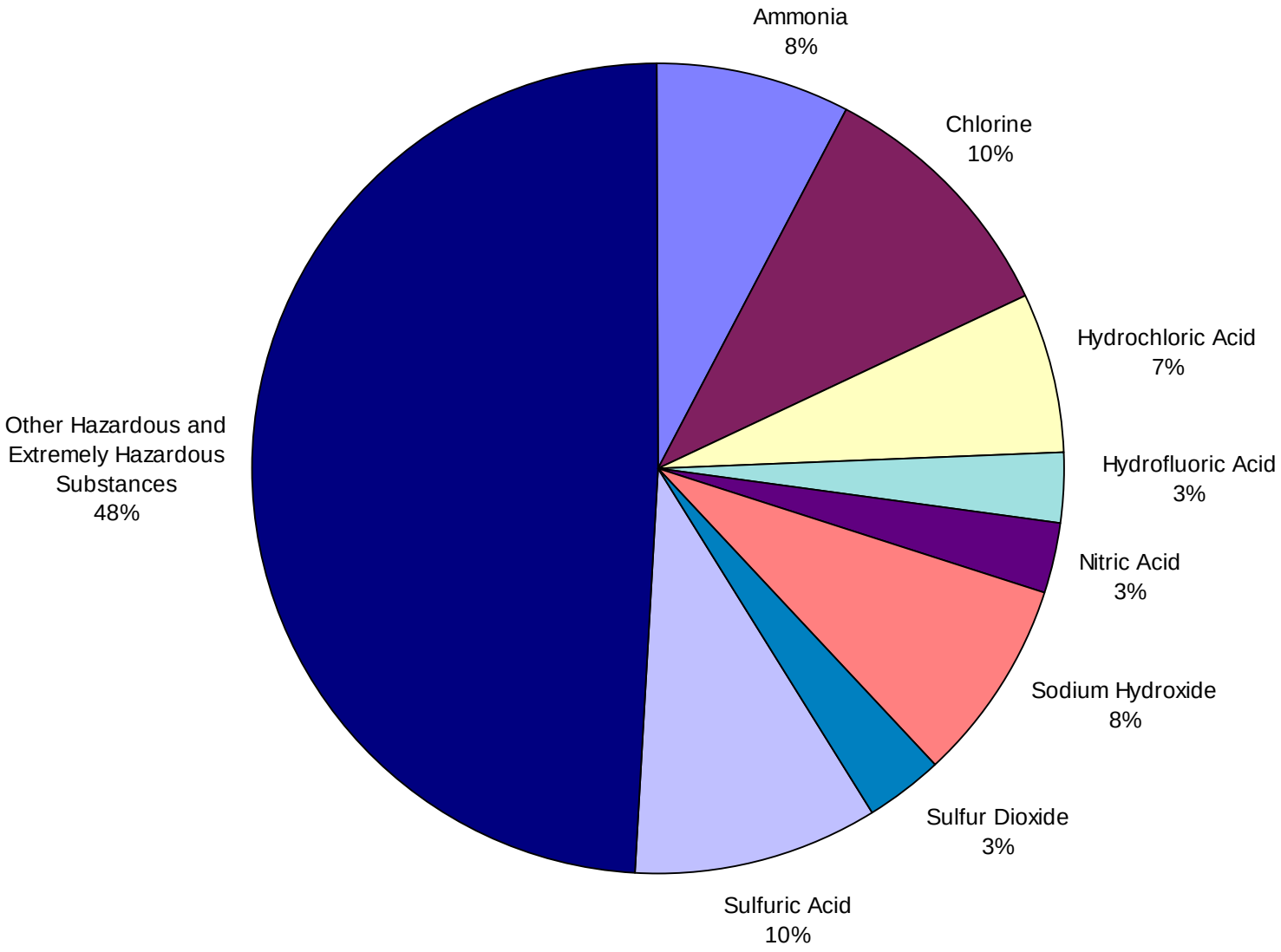


Exhibit 5
Chemical Safety Audit Workshop Attendees by Affiliation
FY 89 through FY 98

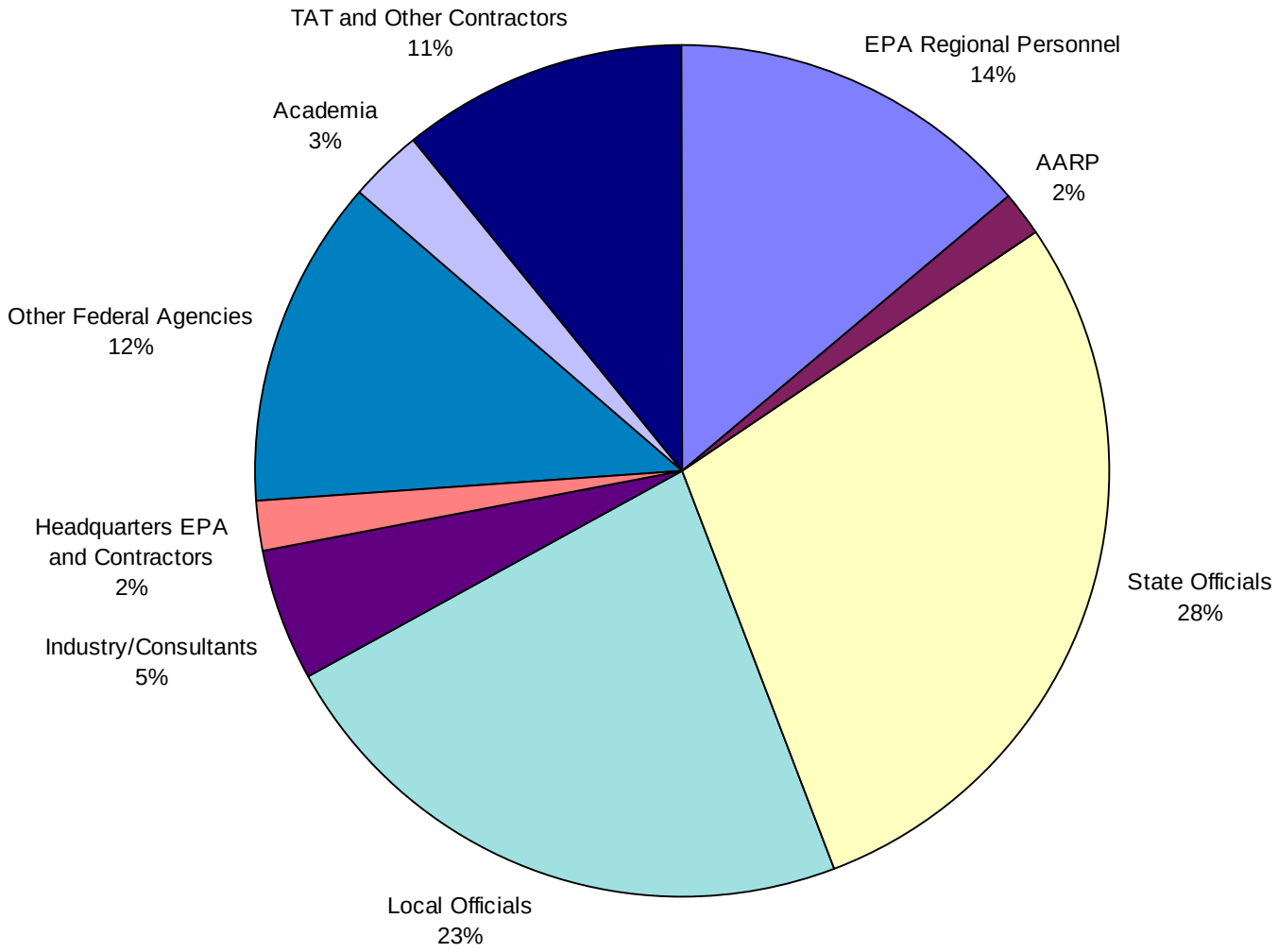
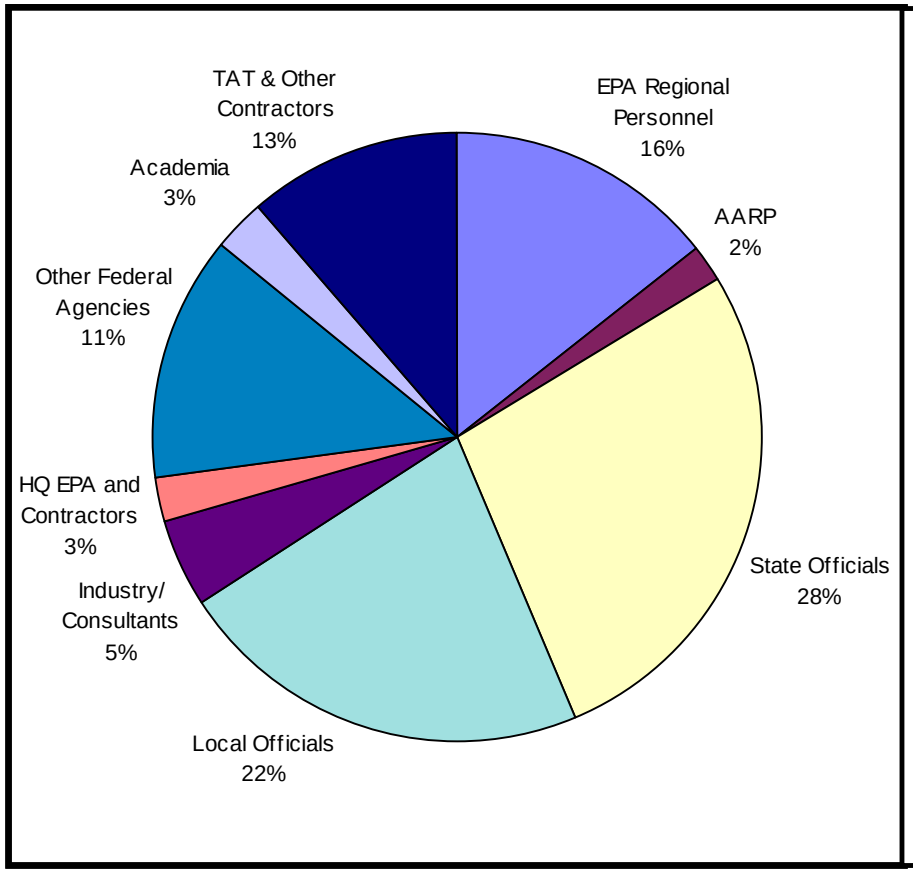


Exhibit 6
Chemical Safety Audit Workshop Attendees by Affiliation
FY 89 through FY 98

FY 89 through FY 97



FY 98

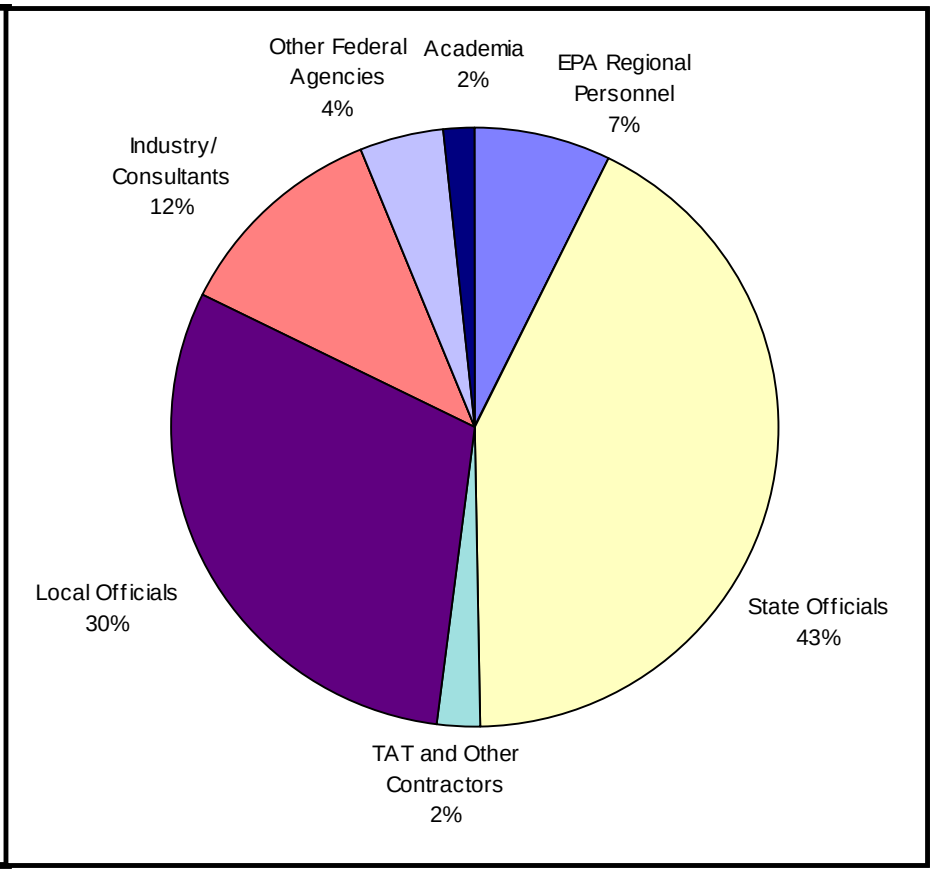
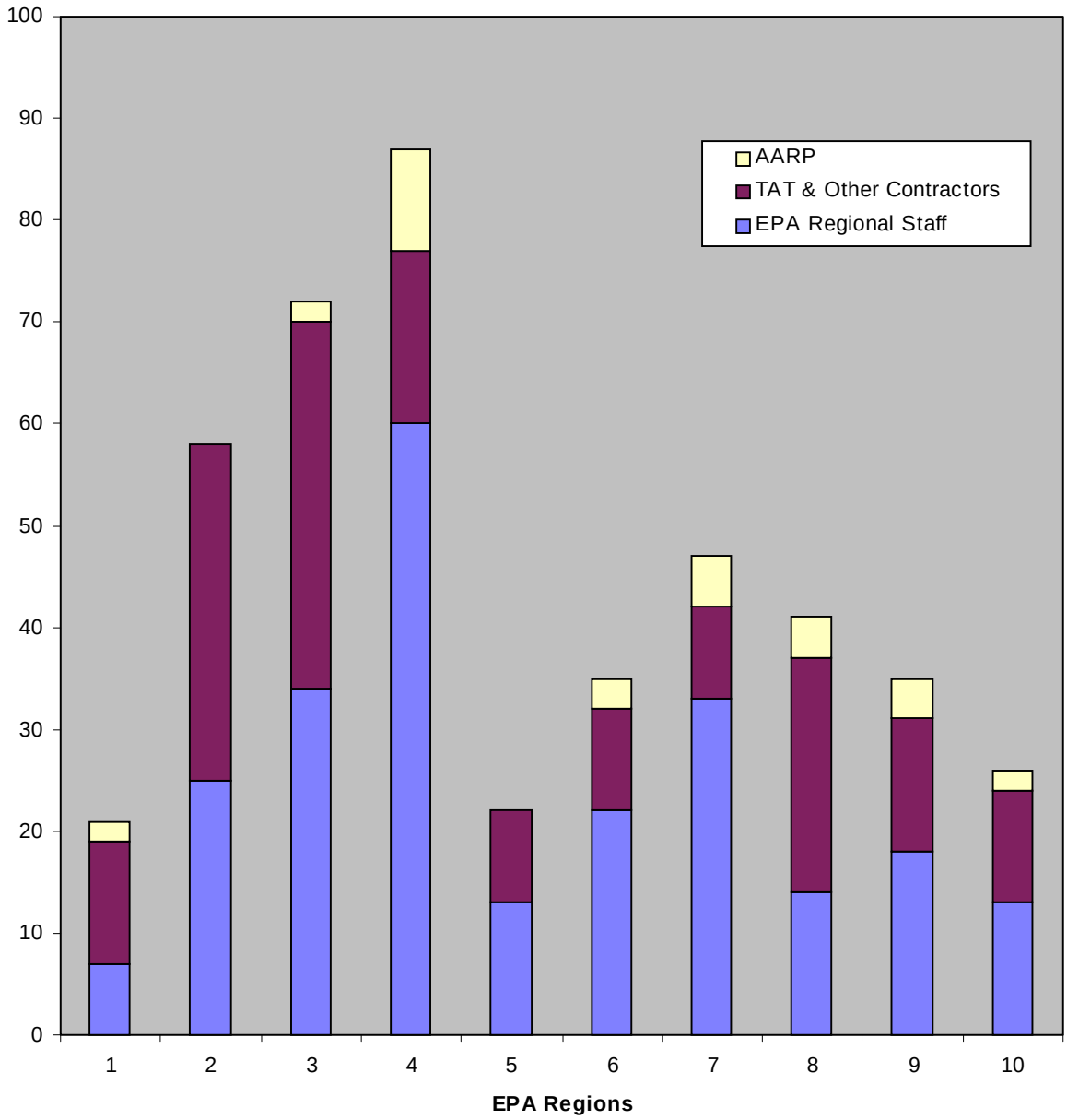


Exhibit 7
Chemical Safety Audit Workshops:
Number of Persons Trained by EPA Region
FY 89 through FY 98



3.0 OVERVIEW OF CSA REPORT FINDINGS

This chapter presents a review of conclusions and recommendations taken from recent EPA chemical safety audits, based on the latest 14 final CSA reports received by EPA headquarters as of September 30, 1998. The results are organized according to the generally recognized elements of chemical process safety management practices, which form the basis for the risk management program regulations issued under CAA section 112(r) (see 40 CFR part 68), and OSHA's Process Safety Management (PSM) Standard (29 CFR 1910.119). These principles are specifically applicable to facilities with complex operations and chemical-based hazards, and, thus, in their detail may not be appropriate for simpler operations that do not involve chemical processing.

These chemical process safety elements are closely related to those of the CSA protocol, an outline of which can be found in Appendix A. The following 17 chemical process safety management elements are examined in this chapter of the report:

- Corporate and facility management
- Process hazard analysis (hazard evaluation)
- Offsite consequence analysis
- Process safety information
- Standard operating procedures
- Equipment and instrument maintenance
- Training
- Safety audits
- Accident investigation
- Management of change
- Pre-startup review
- Contractors
- Employee participation
- Hot work permits
- Release prevention and mitigation measures
- Facility emergency preparedness and response
- Community emergency response coordination

Each section of this chapter begins with an italicized overview of the key components of the corresponding chemical process safety management element, followed by an overview of audit team observations in the last three years and a discussion of facility practices described in the latest chemical safety audit reports. CSA report conclusions highlight chemical process safety practices observed at the facility; they reflect the audit team's perception of the facility's understanding of and commitment to chemical process safety management, but are not judgments of adequacy or inadequacy of the practices observed by the team. CSA report recommendations address options that the facility may consider implementing to enhance facility knowledge of and practices in chemical process safety management. These recommendations are based solely on areas observed during the audit and are not required or mandatory actions to be taken by the facility, although audit teams do examine facility practices that are directly related to the components of existing federal regulatory programs (e.g., emergency response plans).

3.1 Corporate and Facility Management

Corporate and facility management play an integral role in ensuring a coherent and consistent approach to chemical safety and health issues at a facility. Corporate management has the unique role of fostering communication among and providing guidance to operations within the corporation, while facility management is better suited for addressing site-specific issues. The degree of support and resources dedicated by corporate and facility management has a direct impact on the effectiveness of all aspects of chemical process safety programs. Identification of responsible personnel is also a key step for ensuring effective process safety management.

Corporate management can play an important role in ensuring that all facilities in a corporation have access to process safety lessons learned. This is especially critical when a single corporation maintains numerous facilities conducting similar processes. For instance, in a previous year, the corporate management of one facility required that all spill reports be submitted to the corporate office, which then produced a quarterly spill summary documenting incidents and actions to be taken. The corporate headquarters for a network of 32 refrigeration facilities promoted information-sharing and lessons learned between similar facilities by disseminating similar information.

Corporate management can also play a role in monitoring regulatory changes and providing other skills and services that could not be maintained or developed cost-effectively at each facility. Corporate management of a cleaning and sanitation products manufacturer has contracted for two audits of its fire safety systems and is audited every two years by its corporate environmental health and safety department. Several local audit procedures are also in place at a chemical manufacturing facility. The facility conducts an internal audit of about 60 safety and housekeeping subjects as part of a weekly "safety climate index," which is calculated from assessing 10 rating criteria the facility believes influence safety. Additionally, the personnel at a scientific research center displayed a management philosophy committed to safety and environmental concerns. The laboratory director is responsible for health and safety within the facility, which conducts safety audits at various levels throughout out the year. Emergency preparedness plans are well-written and comprehensive, and each facility has its own personnel responsible for the emergency preparedness program. The plan also encompasses special provisions for the disabled and personnel with language barriers.

Audit teams encouraged corporate management for several facilities to take a more active role in developing standards for emergency scenarios. For instance, although facility personnel of a frozen food products manufacturer routinely review Tanner Industries OSHA 200 logs to ensure that suppliers

maintain an acceptable safety record, facility personnel have not conducted any modeling using release scenarios to predict potential consequences of hazardous chemical releases. Audit teams suggested that modeling activities be organized with the local HazMat Coordinator to identify potential vulnerable zones in each scenario, and that the results be used to evaluate the facility emergency action plan to ensure that it addresses problems associated with each release scenario and model result. Similarly, in a previous year, corporate management of a brewery, although active in other areas of process safety management, was prompted to make computer modeling results of hypothetical ammonia releases at one of its facilities available to other facilities where ammonia is used.

Audited facilities use a variety of management techniques to disseminate process safety information within the facility. For example, the corporate office at a chemical manufacturing facility has established written guidelines to address safety, health, and environmental issues at the facility level. The facility is expected to develop and amplify these guidelines into applicable local policies and procedures. The plant manager has responsibility for all local safety, health, and environmental matters; safety and health issues have been delegated to the safety-emergency response specialist; and environmental matters have been delegated to the environmental manager. The unit manager and operations engineer serve as the OSHA process safety coordinators. Additionally, the facility is a member of the Chemical Manufacturers Association (CMA) and has an active Responsible Care program, and facility personnel are also active in the LEPC. The facility is ISO 9000 certified, and facility processes are subject to the OSHA Process Safety Management Program (PSM) Standard. In previous years, a typical facility established a safety committee consisting of both staff and management and uses monthly safety meetings with all personnel to share company memoranda and review any safety literature. The format includes a presentation, open discussion, and then a quiz. This same facility ensures that a single individual is responsible for ensuring effective process safety management, with the plant manager's annual appraisal dependent, in part, on achieving specific environmental and safety objectives.

3.2 Process Hazard Analysis

Process hazard analysis (PHA), also known as hazard evaluation, is a key factor in the prevention of chemical accidents and, generally, in the management of safety at a facility. A process hazard analysis identifies the hazards at the facility, helps assess the risk posed by the hazards, evaluates the consequences of the hazards, and identifies ways in which the hazards can be controlled or mitigated, thus directing facility attention to areas in most need of improvement. In conjunction with the management of change, this analysis serves as a foundation for the ongoing revision of a facility's accident prevention efforts. Although there are several methods for performing this analysis, each approach will provide the facility with information on identifying potential accidental release scenarios and, thus, support the preparation of an offsite consequence analysis.

For more complex chemical processing operations, facilities conducting a process hazard analysis should use one of the generally recognized formal techniques (e.g., What If, Checklist, What If/Checklist, Hazard and Operability study (HAZOP), Fault Tree Analysis, or Failure Mode and Effect Analysis); less formal approaches may be sufficient for simpler operations. Depending upon the complexity of the process(es) being examined, facilities may find that a review of the hazards posed by a process, rather than a detailed PHA, may be sufficient to carry out the aim of effective process safety management. Facilities should implement the results of the analysis; this process should be tracked to determine whether recommendations are implemented in a timely manner. Finally, the evaluation should be updated periodically or whenever a process modification is introduced.

Although most facilities have at least an informal program to evaluate hazards, a number of audited facilities have formal hazard analysis programs that are designed to enhance process safety management and identify areas for improvement in facility practices. In previous years many audited facilities had used the HAZOP methodology for evaluating hazards in their processing operations. A similar trend continues this year. For instance, one medical manufacturing facility had a consulting firm conduct extensive HAZOP studies of the major processes at the plant. The facility evaluated the findings of the HAZOP studies and made appropriations in the 1998 budget to address the most critical changes. Another facility has recently secured, but not installed, software for use in conducting PHAs. The facility plans to use this program to track recommendations for all HSE-related programs.

In some cases, the audit teams noted that PHA programs at facilities were incomplete or needed improvement. For example, one frozen foods manufacturer is still in the process of developing a list of possible problem scenarios that would lead to operating and maintenance procedures; also the facility has not conducted any ammonia modeling using the release scenarios that are under development based on informal PHAs. The audit team encouraged the facility to develop a more structured approach to identifying problem scenarios, and suggested that the facility should develop at a minimum, a "what-if analysis" approach to this process. At a chemical facility, the audit team observed that maintenance activities are not included in the PHAs, and suggested that PHAs should at least be conducted for non-routine activities. The audit team also urged the facility to consider incorporating the requirements of 40 CFR Part 68 when updating existing PHAs. In another audited chemical facility, the audit team recommended that the facility could use the "Event Tree Analysis" approach to provide additional information that would prove useful in emergency scenario development.

Among the 14 audit reported completed this fiscal year, the audit team noted that one facility had performed no hazard evaluation. In addition, the audit team found that the facility does not use any dispersion or release modeling to predict the path of airborne release.

3.3 Offsite Consequence Analysis

An offsite consequence analysis is designed to assess the potential impacts of a release of a hazardous chemical on the populations and environments surrounding a facility. Based on the potential hazards identified in the process hazard analysis, facilities should examine a range of potential accidental release scenarios to identify the potential offsite consequences and evaluate the likelihood of the release occurring. As a result, the offsite consequence analysis will help facilities establish emergency response needs and priorities in the case of a release (and the implementation of measures to prevent or mitigate such events) based on both their potential impact and their likelihood of occurrence.

As was the case in last years audit report findings, only a few audit teams found that facilities were using offsite consequence analysis to evaluate potential hazards. At one of these facilities, a medical manufacturer, an internal risk survey conducted by plant personnel several years ago identified the chlorine and hydrochloric acid handling systems as having the greatest potential for significant offsite impacts. Based on this finding, a quantitative risk assessment was conducted for the facility in 1991. However, audit teams also observed that since this effort, a regional prison with 1,000 inmates has also been established adjacent to this plant. One scientific research facility uses modeling to evaluate atmospheric non-radiological releases of hazardous substances with the utilization of meteorological, source term and site-specific data. At another chemical facility, the audit team noted that probably the greatest deterrent to a significant off-site release is the presence of a large buffer zone surrounding the process area.

Audit teams in a few instances noted that facilities are not implementing offsite consequence analyses. Last year, one of the audit teams had noted how one facility, located near two elementary schools, a hospital, and two public parks, does not perform any modeling to track releases into air, surface water, or groundwater, and also noted problems with the vulnerability zones identified for chlorine and ammonia releases at the facility. This year, the audit team at a frozen foods processor noted the absence of a structured approach to the offsite analysis modeling; the audit team suggested that the facility should coordinate release modeling activities with the HAZMAT coordinator from the city to identify vulnerable zones of different scenarios. In addition, the audit team also recommended that the facility provide modeling information to the local fire department for use during an off site release.

3.4 Process Safety Information

Documentation of process safety information (including chemical hazards and process technologies and equipment) is important because a facility's accident prevention program must be based on up-to-date information on chemical hazards, processes and equipment. Data on chemical hazards ensure that a facility's employees understand the inherent toxicity of a substance, as well as the potential for fire, explosion, corrosivity, or reactions with other chemicals. Current data on processes are imperative to conduct a hazard evaluation and to implement effective standard operating procedures, training, and maintenance. Equipment information-piping and instrument diagrams, materials of construction, electrical classification, relief system design and design basis, ventilation system design, design codes and standards employed, material and energy balances, and safety systems - should be documented and kept current.

In many of the facilities that were audited, audit teams made specific mention of and commended facilities who made Material Safety Data Sheets (MSDS) information readily available and understandable to employees. In previous years, audit teams had noted instances of facilities maintaining electronic versions of MSDSs of different chemicals in the facility. Once again among the facilities audited this year, a significant number of the facilities maintained computerized copies of MSDS information. For example, at a large chemical facility a file of MSDSs for the chemicals used in each area is kept in the control room and at the main gate. MSDSs are also on computer file, and the environmental area managers are responsible for updating the information. In addition, all employees are responsible for updating this information. One refinery has made hard copies of MSDSs available throughout the facility and is currently transferring these files to the facility intranet.

In some cases, audits also revealed facilities whose chemical hazards were not formally identified or were poorly documented. At a scientific research laboratory, the audit team found that updated hazardous waste inventory information is not readily available to the local fire department, especially after business hours. One of the buildings in the facility was found to lack a mechanism to access information regarding hazardous waste inventory on a day-to-day basis.

Other audits revealed the need to take further steps to make chemical hazard information more readily accessible to employees. At a frozen foods processing facility, the audit team suggested that as the facility continues to develop its PSM program, refrigeration system procedures should include information on the consequences of parameter deviations. At another facility, the audit team recommended that the facility personnel should review their own MSDSs to ensure that each MSDS contains all the required information, that the information is easily read, and that consistent language or abbreviations are used for information that is not known or available.

3.5 Standard Operating Procedures

Standard operating procedures (SOPs) provide the basis for coherent, safe facility operations by supporting safety in day-to-day activities and in operator training programs. SOPs describe site access, process startups and shutdowns during routine and emergency operations, lockout and tagout, confined space entry, opening process equipment or piping, storage, handling, loading, and unloading. SOPs addressing operating parameters should include operating instructions about pressure limits, temperature ranges, flow rates, and steps on how to handle process deviations. Furthermore, SOPs should be reviewed as necessary to ensure that they reflect current operating practices (including changes that result from alterations in process chemicals, technology, equipment, and modifications of the facility) and that current information is transmitted as part of employee training.

Most large facilities audited had extensive SOPs for their processes. Audit teams cited many examples of thorough SOPs that were formally documented and implemented by employees. One such facility, a specialty anesthesia inhalation gas manufacturer, had systematic, established accident and incident investigation and reporting procedures codified in a bilingual SOP. The investigation and reporting SOP covers near-miss accidents, as well as all incidents involving fires, environmental property damage, and product losses. The facility's investigation approach goes beyond the immediate cause to include the basic cause: the underlying procedures or practices that created the conditions in which the immediate cause occurred. Procedures for conducting, documenting, and reporting of incidents and follow-up are defined. Additionally, the SOP further establishes responsibilities for individuals and the investigation team, sets time frames depending on the severity of the incident, and establishes follow-up procedures and accountability for remedial procedures that may have to be implemented.

Audit teams frequently made suggestions regarding potential improvements to the SOPs even at facilities that maintain detailed SOPs. A multi-disciplinary scientific research center had written SOPs pertaining to radiological and toxic emergencies. These procedures are outlined in the lab's emergency plan and are maintained by each emergency response unit. However, lightning protection was not addressed in the SOPs. The auditors stated that lightning protection should be addressed in the fire department's SOPs on fire safety and should include mitigation measures to minimize exposure during firefighting, including personal protection training for all firefighters. In addition, each facility should establish provisions to identify potential lightning hazards during evacuations and establishing alternate evacuation locations in the event of lightning situations. Another facility, which manufactures bleach-based cleaning products, maintained written health and safety SOPs for most of its processes. Through interviews with employees and observations, the audit team determined that the personnel understand the direct consequences of not following SOPs, one of which can include termination of employment. However, the auditors recommended that the facility consider revising its SOP which currently requires only one emergency responder for each action to be inside the plant in the event of an emergency. The buddy system should be implemented to ensure the safety of responders.

Typical problems with SOPs observed by the audit teams ranged from a lack of formal written procedures to insufficient documentation and failure to cover all operations. In a previous year, for example, a manufacturer that receives and stores corrosive acids maintained SOPs for loading and unloading procedures. However, the audit team found that the SOP was not sufficiently detailed and recommended that the facility prepare a more detailed SOP for the loading and unloading of hazardous chemicals, including emergency response considerations. Other facilities were encouraged to make changes in their SOPs to make them easier to read and reference. For example, a chemical manufacturing facility had SOPs that the auditors found to be very detailed, but with no distinction

between action items and general information. In addition, start-up, shutdown, and emergency procedures are not provided in a checklist form. Although the training specialist generally updates and maintains the procedures, not all operating steps required by the PSM standard are addressed; only those steps the facility believes to be applicable are covered. The audit team recommended that facility personnel continue to revise its SOPs and separate action items from general information.

Several audit teams found that facilities' SOPs were not reviewed with sufficient frequency or that revisions were not clearly documented. For example, in previous years, several audited facilities recognized the need to update their SOPs more regularly, but had not yet begun this process. One poultry processor was organizing their SOPs at the time of the audit. The facility reported that, when this process is complete, SOPs will be reviewed annually. The audit team recommended that the date of the review and the reviewing person(s) should be recorded on the document whenever an SOP is revised or updated.

Several facilities are voluntarily participating in programs to verify or improve environmental and safety processes. However, even these facilities frequently were found to limit their SOP development or review to the levels required for such programs. For instance, in a previous year, a chemical corporation has completed an ISO 9002 registration audit and received certification; all SOPs and other documents are prepared and controlled in accordance with ISO 9000 requirements. However, the audit team recommended that the facility generate and implement a schedule to update its SOPs. Another facility in a previous year, a paper processing plant, developed SOPs in accordance with ISO 9002 standards, as well, and has expanded its SOPs to include OSHA PSM requirements for covered processes only. The audit team recommended that the facility consider standardizing its SOPs in the OSHA PSM format.

3.6 Equipment and Instrument Maintenance

Equipment and instrument maintenance falls into two categories: predictive/preventive maintenance, which is performed to avoid equipment failure or breakdown, and emergency maintenance, which is performed in response to equipment failure. While emergency maintenance is an essential element of any facility safety program, systems of predictive or preventive maintenance are essential to the prevention of equipment failure and subsequent releases. The purpose of a maintenance program is to ensure that equipment is regularly monitored and serviced so that emergency situations do not occur; this can help not only to prevent releases, but also to decrease facility downtime and increase overall efficiency. To be effective, maintenance programs should cover chemical process and handling equipment, instruments, and emergency response equipment.

For larger, chemical processing operations, generally accepted practices for a comprehensive maintenance program include developing a list of critical equipment and controls; designing a maintenance program that includes procedures and schedules; training employees in maintenance procedures; and ensuring that maintenance supplies are suitable for the facility's purposes. Most successful programs for large or complex facilities include the use of computer databases or other systems to track maintenance activities. Smaller or less complex facilities may, however, find that a less formal process can also result in an effective preventive maintenance program.

Many audited facilities use computerized tracking systems to run their preventative maintenance programs. For example, a chemical manufacturer tracks its maintenance on a corporate-wide computerized system from which work orders are generated using the NEXUS Manufacturing

Information System. Collected maintenance work history is then used for preventive and predictive scheduling where possible. However, maintenance activities are not included in the facility's PHAs. Work that may involve change, as defined by PSM, is evaluated using a management of change procedure. Work orders for inspecting critical equipment, as required by the OSHA PSM, are generated automatically. While considerable work has been done, the facility recognizes that additional work is needed in the mechanical integrity area. Written permits are required before any hazardous maintenance work is performed, and special permits are required before doing hot work, excavation, confined space entry, fire protection water system modifications, asbestos removal, high altitude work, and exhaust system modifications. A "lock and tag" procedure is used when any piece of equipment with the potential to release energy is shut down for maintenance or cleaning.

Many of the facilities do not have outstanding preventive maintenance practices or elaborate systems to track and predict maintenance needs. However, many performed systematic preventive maintenance nonetheless. At an electronics component manufacturer, maintenance is scheduled for some machines and instruments, but most repairs are done on an as-needed basis. An audit team recommends that the facility implement a preventative maintenance schedule for all machines and instruments.

Other facilities do not conduct thorough preventive maintenance programs. For example, a food manufacturer does not have a working maintenance procedure and documentation program in place, but is in the process of developing one. An audit team stated that facility personnel should consider including the following elements from 29 CFR 1910.119 in its written training documentation program: information on the hazards of the chemicals in the process (29 CFR 1910.119[d][1]), information on the technology of the process (29 CFR 110.119[d][2]), and information on the equipment used in the process (29 CFR 1910.119[d][3]). In a previous year, at a chemical manufacturer, a manual maintenance work order system was used, and additional work was needed to complete the facility's mechanical integrity program. The audit team recommended that this facility evaluate the benefits of using computerized systems for the work order system, complete a mechanical integrity program, and consider implementing a preventive maintenance program.

In previous years, although some audited facilities incorporated emergency equipment into their regular maintenance programs, and others conduct these activities in conjunction with drills and exercises, other facilities did not have procedures to maintain their emergency equipment. For example, a chemical manufacturer inspected its emergency equipment weekly. Documentation of these inspections was maintained in a binder located in the environmental health and safety department, but was not included in the facility's contingency plan. At a refinery, the audit team recommended that the facility begin regular maintenance of its emergency equipment stations. However, other facilities had thorough emergency equipment maintenance and inspection procedures. For example, a brewery inspected and inventoried its emergency equipment cage monthly, and restricted access to this equipment to authorized personnel by a keypad security code. The encapsulating suits and other equipment with specified shelf lives at this facility are checked during each inventory to ensure that they are still within their manufacturer's recommendations.

The depth and quality of the training afforded to maintenance workers can also affect the quality of a facility's maintenance program. For example, in a previous year, an audit team observed that a chemical manufacturer did not have a formal training program for maintenance personnel. However, the new maintenance manager at this facility received permission to allow personnel to attend trade shows as well as classes at equipment vendor schools and on programmable logic controllers. There are no equipment history records for the time prior to the hiring of the new maintenance manager. However,

this new manager is now instituting a system to support both preventive and predictive maintenance programs.

3.7 Training

Training of supervisory and operations personnel provides the most immediate opportunity to increase awareness of chemical health and safety issues and ensures the competence of employees in performing their responsibilities. Training programs are the key to ensuring the effectiveness of SOPs, maintenance programs, pre-startup reviews, and emergency response. Refresher training ensures that established employees are reminded of appropriate procedures periodically and of alterations that have occurred. To minimize the risk of accidents occurring because employees are unfamiliar with their assigned tasks, a successful training program for a facility with complex, chemical processing operations should include the following: initial and refresher training for all employees; procedures to confirm that all employees are competent to do their jobs safely; additional training after any change is made to the process or to the facility overall; and formal documentation. Smaller operations, and those with more limited chemical handling activities, may find a less formal program sufficient to fill their health and safety needs.

Many of the facilities audited had implemented the basic components of a training program, including training policies and schedules, refresher courses, and incorporation of management of change procedures. For instance, a multi-disciplinary scientific research center trains its new employees on general emergency response procedures, including emergency operations and shutdown procedures, as well as safety rules. Further general training is provided in hazard communication and laboratory procedures, and job-specific and advanced training is then provided by each department, including HAZWOPER training for all applicable staff.

A manufacturer of various bleach-based cleaning agents trains its employees in all areas of operations including emergency response, health and safety, equipment operation, and general worker safety. Types of training include general safety, first aid/CPR, Right-to-Know, Lock Out/Tag Out, Confined Space, Respiratory Protection, Self-Contained Breathing Apparatus (SCBA), HAZMAT, Emergency Response, Scrubber, Interscan, Draguer, Sensors Calibration, Chlorine Alarm, and Fire Alarm.

Audit teams did suggest specific improvements to round out training programs at several facilities. One chemical manufacturer has developed training courses for its employees on hazard communication, emergency response, and chemical hazards, which is given using video presentations and question and answer sessions. The audit team encouraged the facility to continue to improve the hazard communication, emergency response, and chemical hazards training programs and increase chemical safety awareness in the facility by updating all programs in light of any new regulatory requirements. Another audit team encouraged a refinery to develop an electronic tracking system to readily show that employees are current in required training.

One or two audited facilities had no formal training programs. For example, one audit team recommended that a sanitation products manufacturer institute a formal centralized training program administered by qualified and certified health and safety professionals in addition to its current training in which new employees work alongside experienced employees. Other facilities had training requirements, but no formal training procedures. For instance, an audit team encouraged an agricultural chemical manufacturing facility to consider the development of a written operator training program,

complete with job descriptions, training requirements, testing procedures, and competency documentation for both classroom and hands-on training.

3.8 Safety Audits

A schedule of regular audits not only improves specific process unit conditions, but also supports a consistent approach to health and safety issues throughout the facility. The safety audit has two purposes. First, it serves as a tool for management to ensure that covered processes are in compliance with the chemical accident prevention regulations, as well as other environmental regulations. In addition, the audit allows management to perform a "real-time" check on the safety of its operations. A safety audit should include at least one person knowledgeable in the process, a written report with recommendations, and a management response. The size of the safety audit team, and the formality of the follow-up process, can be scaled to suit the complexity of the process being audited. To be effective, management should document actions taken to address and correct deficiencies identified in the report.

Many of the audited facilities conducted safety audits, both internal (i.e., conducted by facility employees) and external (i.e., conducted by other individuals). For example, at an electronics manufacturing facility, corporate management conducts internal environmental, health and safety (EHS) compliance audits annually. Corporate management at this facility also hires an insurance company to conduct annual safety and risk management based audits. One chemical manufacturing facility performs internal hazardous materials safety audits and hires an insurance company to inspect its fire protection systems. The audit team observed that during an internal audit conducted at this facility, a safety shower in the tank room was identified as not having adequate water pressure, and noted that this problem is now being addressed.

Similar to the trend in previous years, some of the larger facilities dedicated substantial resources to audit programs. At a chemical manufacturer, corporate management has detailed audit procedures in place; the facility conducts an internal audit of about 60 safety and housekeeping subjects as part of a weekly “safety climate index,” which is calculated based on 10 safety rating criteria. At a scientific research laboratory, safety audits are conducted internally by different facility departments and safety divisions, and externally by the U.S. Department of Energy, throughout the year.

Unlike in previous years, audit teams did not have any comments this year regarding the specific facilities at which safety audits were not conducted, or were not conducted regularly. In earlier audit reports, audit teams had made specific recommendations to facilities for tracking their internal audit findings and developing written check lists and documentation procedures. This year, in most instances, the audit teams only noted the types of audits conducted at facilities, and did not elaborate on the extent of documentation of audit findings, or the nature of follow-up processes in place. Audit teams also did not offer any specific recommendations to improve the internal safety audits at different facilities.

3.9 Accident Investigation

Facilities should investigate the root causes of accidents to prevent repeated or similar accidents and to assess the need for improvements in equipment, maintenance, training, and operating procedures. The concept of root cause involves identifying management system inadequacies or failures, such as poor design or lack of training, that allow leaks to occur, when, for example, an operator turns the wrong valve in a process line. To address the root cause would be to design a fail-safe process, or make

operators more aware of proper procedures, rather than focusing on the initiating cause and assigning blame.

There are four generally recognized components of a comprehensive accident investigation program. First, the facility should establish procedures to investigate accidental releases or near misses and develop a system to promptly address and resolve accident report findings and recommendations. When a release occurs, the facility should promptly initiate an investigation by a formal accident investigation team to find the facts and root causes of the incident. Next, the team should prepare a summary investigation report that includes key data about the incident and any recommendations for remedying the root cause(s). Finally, the facility should document any resolutions and corrective actions taken and review the accident report with personnel whose job tasks are relevant to the investigation's findings.

Audit teams found that many of the audited facilities had explicit accident investigation procedures requiring follow-up reports or actions. For example, at a chemical manufacturing facility, the facility's Safety Office maintains computerized and hard copy records of injuries, illnesses, and serious accidents. Computerized versions of incident reports at this facility are tracked through a Corrective Action Request (CAR) system. Other features at this facility include:

- Written procedures for accidental releases and incident investigations;
- Formation of an incident committee following an incident, and issuance of final area incident reports to the Safety Office within 21 days of the occurrence of the incident;
- Tracking of recommendations made by the investigation committee on the CAR system; and
- Completion of an Occurrence Closing Report by the investigation area, and submission to the Safety Office for filing with the respective incident report.

While several facilities had elaborate written procedures for investigating accidental releases, audit team members observed that, in many of these facilities, incidents of a reportable release were very rare or had not occurred at all. For instance, at a chemical manufacturing facility, the audit team noted that in the past 12 years, there was only one instance of a reportable release. Some facilities initiated procedures on a case-by-case basis, depending on the severity of the release. For example, at a scientific research laboratory, the more extensive emergencies are investigated by the facility and DOE, and a report is generated from the investigation outlining steps to prevent future releases. In one notable case of a frozen foods processing facility, audit team members noted the absence of any procedures for accident investigation.

In previous years, audit teams had made specific recommendations to encourage facilities to develop more complete accident investigation programs and to more thoroughly investigate the underlying causes of incidents. For instance, at a chemical handling facility audited last year, the audit team had suggested that the facility should develop a formal written investigation procedure, and clearly outline the composition and responsibilities of the investigation team. In general, in previous audits, audit teams had noted that the following elements were commonly observed in the case of incomplete accident investigation programs (1) absence of clearly specified responsibilities for following-up on recommendations from accident investigations, (2) lack of proper documentation of investigation procedures, and (3) no investigation of near-miss incidents. Once again, audit teams made similar recommendations at this year's audited facilities. For example, the audit team at a refinery suggested that the different investigation programs should be consolidated into one comprehensive system that covers all types of incidents, including near misses and also recommended that the facility develop an

incident and corrective action tracking system. At a chemical manufacturing facility, the audit team recommended that the facility document requests for extensions of accident release investigations and amend due dates within the Corrective Action Request System developed at this facility.

3.10 Management of Change

Chemical processes are integrated systems; changes in one part of the process can have unintended effects in other parts of the system. For example, installation of better seals may increase the pressure in vessels and, thus, the opportunity for excess pressure situations to develop. It is, therefore, important that all changes in processes, chemicals, and procedures be reviewed prior to their implementation to identify any potential hazards that may be created by the modification. Chemical processing facilities should develop written procedures to review and manage changes in processes, chemicals, and procedures prior to their implementation. A facility should identify potential hazards that may be created by such changes and ensure that facility procedures, process safety information, training, and process hazards analysis reflect changes and are kept up-to-date. At smaller facilities with less complex chemicals operations, however, such a thorough, formal approach may not be necessary.

Audit teams found many audited facilities had well-developed management of change (MOC) programs. As was the case in previous years, some of the larger facilities had explicit and documented MOC procedures. For example, a chemical manufacturing facility's management of change program applies to most of the OSHA PSM-regulated processes within the facility. At a refinery, the spill prevention control and countermeasures plans are reviewed and updated when any substantive change occurs. These plans are reviewed every three years and a record of change is maintained for two years.

Several of the audited facilities had more informal management of change programs. For example, one chemical manufacturer uses a "three signature approval procedure" to authorize any mechanical changes within the plant. However, the MOC investigations are conducted informally and generally not documented for these types of changes. In a frozen food processing facility, a verbal training program is the only type of training employees receive on new or revised SOPs prior to the introduction of a new or modified process.

In general, audit teams noted that many of the facilities audited this year had implemented MOC procedures; however, audit teams still found that MOC programs were incomplete at some facilities. Audit teams suggested specific improvements to the MOC programs at these facilities. One audit team at a chemical facility encouraged the management to develop a checklist of policies and procedures that contain overlapping information for future use to ensure that changes in procedures are updated throughout facility and corporate documentation. At an electronics manufacturing facility, the engineering service request procedure is designed to allow evaluation of all changes, modifications, and additions to equipment, processes, and materials in the facility. However, repairs and changes are performed on an as-needed basis. The facility does not have a formalized preventive or predictive maintenance program. In this case, the audit team recommended that the facility keep active records of equipment history.

3.11 Pre-Start Up Review

The pre-startup review serves as a final check on management of change. It ensures that all issues have been addressed and all systems have been checked prior to startup of a new or substantially

modified process or after emergency shutdowns for routine processes. Startup of a new or modified system can be a particularly hazardous time, especially for complex processes and those that require high temperatures, high pressures, or exothermic reactions. However, even simple facilities need to conduct such reviews. The basic elements of the pre-startup review involve ensuring that construction and equipment is in accordance with design specifications; safety, operation, maintenance, and emergency procedures are in place; appropriate hazard evaluation activities have been completed; management of change has been followed; and updated training for each employee involved in operation or maintaining a process has been completed.

In line with the trend from previous years, a number of audited facilities exhibited pre-startup review procedures, generally in response to the requirements of OSHA's PSM Standard. Last year, audit team members noted that facilities with the thorough SOPs also had pre-start up review procedures. For example, audit team members at a brewery audited last year, noted that the SOPs clearly specified normal operating ranges, correction of devices, normal operations and shutdown. Once again among the facilities audited this year, audit team members observed that facilities with the most detailed SOP procedures also had pre-start up review procedures. For example, at an agro-chemical manufacturer, the facility personnel are required to review and update the plant SOPs to include guidance on what constitutes short versus long plant shutdowns, correct and detect sensitized conditions during operations and shutdown, and alert staff to the presence of any sensitizing material or condition. As part of the initial training at a research laboratory, employees are provided instruction in emergency operations and shutdown procedures, and safety rules.

Some facilities had pre-start up review procedures, but the audit team noted room for improvement. For example, at a chemical manufacturer, the audit team noted that maintenance is performed during an annual shutdown and on as-needed basis; however, the facility does not document these procedures or record their frequency. At a frozen foods manufacturer, the audit team suggested that the refrigeration system procedures should be reviewed to ensure continuity between different procedures. Currently emergency shutdown procedures at this facility refer to the same control by different identifiers. At one chemical manufacturing facility, the audit team recommended that the facility consider computerizing the checklist for start-up, shutdown, and emergency shutdown procedures. Specifically, the audit team suggested upgrading the current manual system to a system which would prompt the user to check off or enter initials for each item before allowing the user to move to the next item.

3.12 Hot Work Permits

Non-routine work that is conducted in process areas needs to be controlled by the facility in a consistent manner. The relevant hazards should be communicated to those doing the work as well as those operating personnel whose work could be affected. A system of "hot work permits" protects employees and others from potentially hazardous situations resulting from non-routine, "hot work" operations (e.g., welding) that may take place in process areas. Hot work permits should document that the required fire prevention and protection measures have been implemented and should indicate the date(s) authorized for hot work and the object on which the hot work is to be performed.

In past years, audit teams have noted certain common problems in the development and implementation of hot work permits, as a few facilities were specifically identified by audit teams as not having hot work permit programs, and other facilities that did have hot work permit programs were not fully implementing these procedures. These hot work procedures were not covered in many audits.

However, at a chemical manufacturer, audit team members specifically noted that written permits are required before any hazardous maintenance work is performed. Special permits are required before doing hot work, excavation, confined space entry, fire protection, water system modifications, high altitude work, and exhaust system modifications. In addition, a "lock and tag" procedure is used when any piece of equipment with the potential to release energy is shut down for maintenance or cleaning.

3.13 Employee Participation

An important component of a successful process safety management program is active and informed participation by employees. Employees have uniquely informed perspectives on facility processes and situations. Accordingly, employers need to consult with their employees as they develop and implement a process safety management program and hazard assessments. Ideally, safety information should flow both from the employer (e.g., training and education for employees, informing affected employees of the findings from incident investigations, and publicizing company-wide initiatives) and from the employee (e.g., through participation in safety committees, use of anonymous comment boxes, and through membership on safety investigation teams).

Some facilities appeared to have programs in place to encourage employee participation in safety issues. In previous years, audit teams noted that many facilities had programs providing incentives to employees for participating in safety management. For example, at a chemical facility audited last year, the audit team noted that safety awards are given to employees on an ad hoc basis for reaching safety milestones. This year, the audit teams found that facilities adopted various other mechanisms to encourage employee participation. For example, at a chemical facility, individual safety and other performance awards are generally not distributed to personnel. Instead, emphasis is placed on improving performance through behaviourial modification and reinforcement.

A few facilities have safety meetings to promote employee participation. One research laboratory organizes safety meetings on a monthly basis to discuss any special issues and to review safety systems. The meetings at this facility are conducted informally, and there are no records of attendance or meeting minutes. At a chemical manufacturer, the maintenance department conducts weekly working "tool box" safety meetings for all personnel on site. However, the audit team noted that employee involvement in its safety program left room for some improvement. The safety program at this facility is principally driven by the management, with little or no employee involvement. The audit team recommended that the maintenance department should consider providing "tool box" safety meetings for production personnel, similar to those provided for company and contractor personnel.

3.14 Contractors

Facilities that use contractors to perform work in and around processes that involve hazardous chemicals need to include their contractors in the facility process safety management chain. Special efforts must be made to screen contractors appropriately and to assure that contractor employees receive up-to-date training and emergency procedures information. The following activities should be conducted, as appropriate: informing contractors of potential fire, explosion, or toxic release hazards; explaining to contractors the applicable provisions of the facility emergency plan; developing work practices to control the entrance, presence, and exit of contractors in process areas; providing and documenting contract employee training; and evaluating the performance of contractors in fulfilling their obligations.

In audits performed in previous years, audit teams had noted instances where facilities took extra precautions to ensure that contractors were well-informed and trained on facility process safety. For example, at a chemical manufacturing facility audited last year, all outside contractors were required to be fully trained in company health and safety procedures, and contracted drivers were required to pass the minimum training requirements for health and safety. In a few of the facilities audited this year, audit teams specifically noted the role of outside consultants/contractors. For example, at a chemical facility , audit teams observed that an outside consultant was hired to develop a Spill Prevention Control and Countermeasures Plan (SPCC), and in a frozen foods manufacturer, audit teams noted that the facility uses the services of two mechanical and refrigeration engineering consultants to evaluate changes in the refrigeration system. However, in both cases the audit teams did not comment on the specific precautions or measures taken to educate these consultants about safety issues at the facility. In some facilities safety meetings are mandatory for all personnel on site. For example, at a chemical manufacturer, the weekly safety meetings conducted by the maintenance department are attended by all personnel, including contractors.

3.15 Release Prevention and Mitigation Measures

Release prevention and mitigation measures are the practices and equipment implemented by a facility to address the potential for accidental releases of hazardous chemicals. Because each operation is unique, they are by nature site-specific. Prevention systems seek to reduce the likelihood, or severity, of accidental releases of hazardous chemicals. Examples include monitors, detectors, sensors, and alarms for early detection of accidental releases, and backup equipment and redundancy features to protect against sudden accidents or failures. Containment structures, flares, scrubbers, quench systems, and surge or dump tanks, can also act to prevent an abnormal occurrence (e.g., overpressurization) from producing a release. Substitution of hazardous chemicals with less hazardous substances, inventory reduction, and other process design changes can lessen the potential for accidental releases of hazardous chemicals. Finally, practices that may reduce the severity of the impact of a hazardous chemical release (e.g., by containing its spread and neutralizing volatility) can be grouped together as release mitigation systems.

Facilities have implemented technological or procedural solutions to increase their ability to increase their ability to detect and prevent releases. A number of the audited facilities have implemented accident prevention through major efforts to reduce the hazardous and toxic chemicals they use, either across the site or at a single unit that could be involved in a release event. As was the case in previous years audits, the facilities audited this year exhibited a variety of release prevention measures. Many of the facilities have secondary containment systems and high-level alarms on process and storage vessels. For example, at one chemical manufacturing facility, the freon reactors in the process area are double walled with detectors to alert personnel if the inner wall fails. Furthermore, much of the piping containing hydrogen fluoride is also double walled with similar detection alarms.

Some facilities have initiated measures to ensure that operators can spot and correct potentially hazardous situations. One chemical manufacturer ensures that the facility does not accept more than 7,500 gallons of chemicals at any one time. In addition, high level alarms have been installed on tanks to prevent accidental overfilling. Finally, the facility implemented a system where the operator uses a sign-in sheet to allow another operator to know what has been completed in the bleach making process at the facility. Another facility has constructed containment areas to prevent spills from the sulfuric acid tanks located within the facility.

In some specific cases, audit teams noted that there was room for improvement in the release prevention and mitigation measures. At a chemical manufacturing facility, the audit team observed that the containment system at the facility may be inadequate in containing all of the material in the event of a maximum release. The audit team also pointed out the absence of any containment system in the mixing area inside the facility, and in the truck unloading area. At one chemical facility, the audit team noted the absence of ammonia sensors in the process area; the audit team suggested that the facility should install overflow alarm and high-level sensors on the aqueous ammonia holding tank. In addition, the audit team recommended that audible alarms should be activated in the building behind the chlorine process structure.

3.16 Facility Emergency Preparedness and Response

Comprehensive facility emergency planning is a crucial element in effective and rapid response to accidents. An emergency response program prepares a facility to respond to and mitigate accidental releases, thereby limiting the severity of such releases and their impact on public health and the environment. Generally accepted practices with regard to emergency response programs can be grouped into five activities: developing an emergency response plan; training employees in relevant emergency procedures; acquiring equipment to support response efforts; conducting drills and exercises to test the plan and evaluate its effectiveness; and coordinating with the surrounding community. The first four of these activities are dealt with in this section; coordination with the community, a focus of the Emergency Planning and Community Right-to-Know Act (EPCRA), is discussed in the following section. Although there is a common understanding of these key components of an emergency response program, emergency preparedness and response activities nonetheless can vary significantly for facilities of varying size and complexity. Facilities that are small, or where the likelihood of a release is minimal, may choose not to (or be unable to) respond to an incident with their own employees. Such a facility might choose to maintain evacuation procedures and procedures to contact outside parties (e.g., local response agencies, contractors), rather than developing extensive emergency response plans.

Emergency Response Plan

A facility's emergency response plan is a critical element in the auditing process because, in many respects, the plan reflects a cross-cutting set of facility activities and procedures. The plan also demonstrates the facility's commitment to minimizing harm to its own employees and the surrounding community if an emergency situation occurs. During an audit, the team reviews the organization of a facility's emergency response plan, its utility in the potential emergencies that a facility may experience, and its comprehensiveness. An emergency response plan should be comprehensive in two senses: plan elements are addressed in a site-specific, rather than generic fashion, and the plan contains all the critical elements necessary to a successful response effort.

In many cases, audit teams noted that facility emergency response plans appeared to be written to fulfill regulatory requirements, rather than for use in an actual response, although response and evacuation procedures were often included within the plan. Audit teams commented on the presence of multiple emergency plans in some facilities, leading to overlaps and inconsistencies. For example, one refinery maintains multiple plans associated with emergency preparedness, planning and response. This facility maintains a Facilities Response Plan, an Emergency Response Action Plan (developed for smaller spills), and a comprehensive Emergency Response Plan (developed for nonspill-type incidents such as fires, hazardous material spills etc.) In 1996, EPA, in conjunction with the National Response Team, issued the *Integrated Contingency Plan Guidance* to provide a mechanism for facilities to consolidate

multiple plans into a single, functional emergency plan. This document was intended to increase the functionality of emergency response plans examined in future audits. It is noteworthy that a few of the facilities have already developed integrated contingency plans (ICPs). For instance, the ICP at an electronics manufacturing facility covers the chain of command and each individual's responsibilities, along with procedures for discovery, initial response, notification, evacuation, assessment, mitigation, termination, and follow-up of an incident. The ICP at this facility also provides maps displaying evacuation routes and assembly points throughout the plant.

Audit teams found that many of the facilities have designed their response plans to address site-specific factors that are unique to the plant. In particular, some of the larger facilities have developed comprehensive emergency response plans, systems of review of procedures, and trained and equipped HAZMAT teams to carry out responses. For instance, at one chemical manufacturing facility, the emergency procedures manual is formally reviewed by the Emergency Preparedness Committee on even years. Documentation of the revisions are maintained on a cover sheet for the plan, and the review date, revision date, and personnel responsible for the revision are noted. Another facility manufacturing medical products maintains a hurricane contingency plan written in Spanish and English; the plan follows a phased approach that bases specific actions on the anticipated strike time of the hurricane.

Although a number of the audited facilities have specific elements in their response plans that are site-specific, there are certain standard components that can be found in most of the plans. The majority of the facilities have evacuation procedures and have marked escape routes on maps posted around the facility. In most cases, the facilities have evacuation procedures that are well-written and comprehensive, and clear evacuation instructions that are posted throughout the complex. However, in some instances the audit teams noted that the evacuation procedures contained in the response plans were insufficient to ensure employee safety. At one frozen foods processing facility, the audit team found the evacuation instructions in the response plan for ammonia releases to be inadequate; the audit team suggested that the response plan should be amended to require NRC and LEPC notification of a release, and that the instructions should provide for more than one meeting point so that the evacuees will assemble in the same location upwind. At another facility manufacturing medical products, the audit team encouraged the facility to revise the evacuation procedures to account for release location, wind direction and related safety concerns. Sheltering in place was also recommended as an option for specific release scenarios. In one instance (at a chemical manufacturer), the audit team noted that while the facility had written emergency procedures, the procedures did not cover notification or evacuation of adjacent facilities in the event of an emergency. In addition, the audit team also observed that there was no way of determining wind direction in the event of a release within the facility.

Many audited facilities had plans that were insufficiently detailed or were missing information that would be critical in an emergency. One facility's emergency response plan includes an explanation of response command and authority based on a customized version of the National Incident Management System for emergency management; however, the audit team noted that this facility's unified command structure needs to be updated to include interfacing with state and federal environmental and response personnel during emergency and recovery phases of an incident. In another instance, the audit team noted that the lack of clarity in the procedures about the specific responsibilities of different facility personnel in the event of an emergency. The audit team suggested that the management at the facility develop a simplified emergency command and flow chart that summarizes command and control responsibilities for both facility and corporate personnel.

Training

Emergency response training must meet the needs of a facility in addition to complying with all federal requirements; specific training needs may include procedures for spill or vapor containment and fire fighting, or decision-making on the need for response, evacuation, or in-place sheltering. Comprehensive emergency response training programs can cover a wide range of site-specific activities, including evacuation and sheltering procedures, incident command systems, release notification, and fire fighting.

In line with the trend from previous years, audit teams found that a significant number of facilities are taking advantage of offsite training opportunities to allow for a mix of site-specific training and more general response and rescue training in various fields. In addition, many of the facilities are also taking steps to ensure that facility personnel and management are familiar with emergency response procedures and to ensure that a qualified manager is on site whenever an incident occurs. For instance, at a scientific research facility, the facility fire department maintains a comprehensive maintenance and training program. In addition, personnel are required to have eight hours of hazardous materials emergency response training and a total of 17 one-hour modules pertaining to emergency notification, communication, and field monitoring.

However, in some instances audit teams noted that commitment to emergency response training was inadequate or lacking. At one chemical manufacturing facility, audit teams found that employees are not provided emergency fire training, although the facility has an "internal fire brigade."; the audit team encouraged the facility to provide personnel with appropriate training, in accordance with OSHA regulations. At another facility, the audit team found room for improvement in the training of employees on the use of SCBA. Facility personnel were encouraged to increase the frequency of the training (they are currently an annual feature), and ensure that employees don the SCBA and breath a cylinder of air while performing a task in order to acclimate themselves with the equipment.

Emergency Equipment

Emergency equipment, ranging from safety gear to response vehicles to communications apparatus, must be available to implement the emergency activities designated in the plan. However, with the exception of OSHA fire prevention regulations, there are no detailed federal requirements on what equipment must be available to respond to a hazardous materials emergency. As a result, each facility must decide which equipment is necessary to address likely accident scenarios and develop a system for maintaining it. In addition, to be effective, response equipment should be staged in areas not likely to be affected by an incident, but close enough to be quickly accessed by response personnel.

Facilities often need a range of equipment that can include personal protective equipment, SCBA, safety showers, and eye-wash stations; absorbents, neutralizing agents, and booms; portable pumps and hoses and fire monitors; response vehicles; and monitoring instruments, as well as backup equipment. Some audited facilities keep a significant amounts of response equipment and maintain it on a regular basis. For example, emergency equipment at one large chemical manufacturer includes a fire truck, ambulance, and an emergency response vehicle. In addition to these response vehicles, the facility's inventory of response equipment includes air monitoring equipment, tools, personal protection equipment, tank repair kits, pumps and compressor hoses, and tank entry equipment. At a chemical facility in Puerto Rico, the audit team observed that the facility did not have any signs on its storage cabinets (SCBA storage cabinets) to identify its contents to emergency providers. Furthermore, there are

no signs to distinguish between the empty and the full breathing air tanks used for emergency responses and personal protection. The audit team recommended that all SCBA tanks that are out of service should be tagged and placed in an area away from full bottles. Identification of service status was also recommended for all storage cabinets. At an electronics manufacturer, audit teams noted the presence of extensive communications apparatus designed to aid in the event of an emergency; the facility has fire alarms and closed circuit television surveillance cameras which provide security for hazardous material and waste storage areas, telephones throughout the plant, a beeping system, a paging system, and walkie-talkie radios to provide communication.

Some facilities, however, either did not have certain emergency response equipment that would be needed in a response or did not ensure that it was accessible when needed. For example, audit teams at a scientific research facility found that the facility did not have any wind direction devices (i.e. wind socks) noted on the site. As a result, during an emergency, responders may be unable to determine wind direction and could possibly encounter a plume.

In other cases, response equipment was present, but was difficult to locate or reach. For instance, at a scientific research facility, audit teams observed that the eyewash stations, emergency stations, emergency showers, and fire extinguisher areas were not clearly visible due to lack of color contrast or labeling. In addition, fire extinguishers throughout some areas audited were obstructed or not readily visible, and in other cases were blocked by large objects that would impede access. At a chemical manufacturer, audit teams found that safety equipment, spill prevention, and fire suppression systems were not easily discernible due to the lack of contrasting background colors. The audit team suggested that the facility should ensure that all chemical containers, tanks, and storage areas should be labeled legibly, with lettering visible from 50 feet, and also recommended that containers received and shipped by the facility should be appropriately labeled with required hazard communication markings and proper DOT shipping labels. At another facility, audit teams encouraged the facility personnel to verify that all fire hoses are serviced, tested, and marked as required by NFPA Standard 1962, and to ensure that background areas around all fire fighting equipment are painted red in accordance with the ANSI Standard Safety Color Code.

Some facilities were found lacking with regard to fire protection and other safety equipment. At one facility fire doors were noted to be chained, closed, or choked open. Furthermore, the audit team found that one of the doors is constructed of a chain link fence, which is not a fire retardant barrier . At another facility, the audit team observed locations where safety shower and eye wash stations were located in close proximity to electrical equipment. The audit team suggested that the facility should inspect the safety shower and eye wash stations to ensure that in their use water would not spray or run onto electrical outlets, switches, or other energized devices.

Drills and Exercises

Drills and exercises supplement training and allow each employee to understand more clearly what steps to take in the event of an emergency. Testing emergency procedures, such as evacuation routes, internal/external alert systems, and community coordination, enhances response time and demonstrates whether the procedures are viable in an emergency. Drills and exercises generally cover evacuations, fire fighting, and medical and rescue operations; field response to a hazardous materials event may also be addressed, although generally with somewhat lesser frequency.

Almost all the audited facilities conduct drills and exercises, although some facilities did not have a regular schedule for conducting such activities. Most facilities conduct drills and activities generally on an annual basis. The schedules were found to be more structured in some facilities compared to others. For instance, the Emergency Preparedness Committee at a large chemical manufacturing facility manages the drill schedule by coordinating activities between facility areas and departments, assigning the drill team and issuing critique reports. The Fire Protection Supervisor coordinates fire brigade activities in scheduled drills, manages fire brigade training, and manages drill functions specific to fire protection. Each facility area conducts annual tabletop drills that address emergency responses requiring only area response. An annual plant wide emergency response exercise that mobilizes community responders is also performed. This exercise is designed to involve the local fire department as well as the LEPC. At another medical manufacturing plant, facility wide evacuation drills are conducted twice a year on each shift. In addition, the fire brigade conducts joint drills with the local fire department during both day and night shifts.

Depending on the facility, these efforts involve local response organizations and neighboring facilities in varying degrees. At one chemical facility, the audit team noted that during the audit the facility management had mentioned a plan to conduct a mock emergency response drill that would involve all local emergency personnel and the surrounding community as well as the EPA. In some instances, the audit teams noted that the notification procedures could be improved. For instance, at one facility, the audit team suggested that the facility should perform an evaluation of the notification procedures in drill exercises, and specifically suggested that the facility should consider providing a list of facility personnel names and phone numbers in descending order of the highest ranking official.

Other facilities conduct joint exercises much less frequently, or not all. In some instances, audit teams encouraged facilities to begin conducting drills and exercises with the LEPC, fire department or other response organizations, and to take advantage of regularly scheduled drills and exercises being conducted in their areas. Audit teams did not specifically discuss whether follow-up on drills and exercises were conducted by facilities.

3.17 Community Emergency Response Coordination

Working with local response organizations and the LEPC on emergency planning initiatives, drills and exercises, mutual aid arrangements, and other response issues completes the circle of preparedness begun with facility emergency preparedness activities. Although many facilities initially respond to and contain an emergency themselves, local first responders are normally involved in responding to those release events that threaten public health and safety. Coordination with public officials is of special importance to those facilities that depend on local responders for response to any onsite incident; appropriate responses to their hazards should be addressed in the community emergency response plan developed under EPCRA.

Almost all of the audited facilities work with the community to some extent with regard to emergency preparedness. For many facilities, this consists primarily of fire prevention and pre-planning with local officials during fire inspections. However, some audited facilities are LEPC members, participate regularly in the local planning process, and distribute copies of their emergency response plan to affected parties within the community. As discussed in the preceding section, a number of facilities also are taking advantage of opportunities to increase emergency preparedness by conducting drills and exercises with LEPCs and local response organizations.

Many of the audited facilities have adopted a proactive approach to working with the community to improve emergency response coordination. For instance, one chemical facility works closely with the LEPC and nearby residents for awareness, training and emergency preparedness purposes. The facility held an open house for residents in the area, and also performs a yearly walk-through with the local emergency responders. In addition, the facility also cooperates with the local fire department, civil defense, and the area hospital, to provide them with an understanding of the chemicals used at the facility. Another refinery has adopted a unique strategy for demonstrating its commitment to the communities in which it operates; this facility has developed partnerships with local high schools in the area and also sponsors a Junior Achievement Program in the area. These features are in addition to the facility's continued involvement with the Mobile County Fire Department (MCFD) and LEPC in the area.

A number of the facilities have also undertaken extensive efforts to develop notification and communication systems for interacting with the local community in the event of an incident, while some of the others depend on local police and fire departments. At one of the audited facilities (a medical manufacturing plant), the facility nurse visits all local hospitals to educate their staff on treatment methods for chemical burns, and the plant manager is identified as being in charge of external notifications. However, the audit team noted the facility has not established any notification procedures or lines of procedures with the prison that is located adjacent to it. In certain instances, audit teams observed that the facility does not have any communication systems in place for interacting with the local communities. For instance, one facility does not participate in any outreach programs with the surrounding community, and does not participate in any joint training activities with the adjoining hospitals or emergency medical services.

APPENDIX A

OUTLINE OF THE CHEMICAL SAFETY AUDIT PROTOCOL

APPENDIX A

OUTLINE OF THE CHEMICAL SAFETY AUDIT PROTOCOL

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APPENDIX B

LIST OF CHEMICAL SAFETY AUDITS

LIST OF CHEMICAL SAFETY AUDITS
as of September 30, 1998

REGION	DATE OF AUDIT	REPORT STATUS	NAME OF FACILITY
1	03/22/89	X	Polysar, Inc., Indian Orchard, MA
	04/10-14/89	X	W.R. Grace, Nashua, NH
	08/03/89	X	Fall River Treatment Plant, Fall River, MA
	08/07-11/89	X	Upjohn Co., North Haven, CT
	11/29/89	X	Bradford Soap Works, W. Warwick, RI
	03/20/90	X	Jones Chemicals, Merrimac, NH
	06/20-21/90	X	Monet Crystal Brands, Pawtucket, RI
	09/12-13/90	X	LCP Chemicals, Orrington, ME
	12/17-18/90	X	Hercules, Inc., Chicopee, MA
	05/13-14/91	X	Pacific Anchor, Cumberland, RI
	07/24-25/91	X	Rising Paper Company, Housatonic, MA
	12/18/91	X	Johnson Controls, Benington, VT
	01/27-30/92	X	Hoechst Celanese, Coventry, RI
	06/25-26/92	X	Pratt & Whitney, Southington, CT
	10/28-30/92	X	James River, Old Town, ME
	05/11-14/93	X	Monsanto, Springfield, MA
	08/24-25/93	X	Davol, Cranston, RI
	03/23-25/94	X	H.C. Starck, Newton, MA
	06/14-15/94	X	Cambridge Plating Company, Belmont, MA
	07/19-22/94	X	Georgia-Pacific, Woodland, ME
2	08/21-24/89	X	BASF, Rensselaer, NY
	09/11/89		**Xerox Corporation, Webster, NY**
	01/09-10/90	X	Du Pont Agrichemicals, Manati, PR
	01/11-12/90	X	Bacardi Rum, San Juan, PR
	07/31 - 08/01/90	X	Goodyear, Niagara Falls, NY
	09/10-11/90	X	BASF, Washington, NJ
	03/11-13/91	X	C.P. Chemicals, Sewaren, NJ
	06/03-05/91	X	3M/O-Cell-O, Tonawanda, NY
	08/05-07/91	X	Schenectady Chemicals, Schenectady, NY
	03/25-26/92	X	CPS Chemical Company, Old Bridge, NJ
	06/22/92	X	Caguas WWTP, Caguas, PR
	06/23/92	X	Puerto Nuevo WWTP, San Juan, PR
	06/24/92	X	Bayamon WWTP, Catano, PR
	11/11-12/92	X	Witco Corporation, Brooklyn, NY
	6/21-23/93	X	ArsynCo, Carlstadt, NJ
	Unknown		**PRASA**
	07/19-21/93	X	International Paper, Ticonderoga, NY
	10/12-13/93	X	Pfizer, Barceloneta, PR
	06/28-30/94	X	Occidental Chemicals, Niagara Falls, NY
	02/01-02/95	X	Hoffman-LaRoche, Nutley, NJ
	07/07/95		**Middlesex County WWTP, Sayreville, NJ**
	09/26/96	X-D	Patclin Chemicals, Yonkers, NY
	05/06/96	X-D	PNC, Nutley, NJ
	05/07/96	X-D	Elan Chemicals, Newark, NJ
	09/12/96	X-D	Dexter Chemical Company, Bronx, N
	06/09/97	X-D	Ecolab, Avenel, NJ
	06/24/97	X-D	Clorox Company, Caguas, PR

REGION	DATE OF AUDIT	REPORT STATUS	NAME OF FACILITY
	06/25/97	X-D	Ohmeda Caribe, Guayama, PR
	09/08-09/97	X-D	Brookhaven National Lab, Upton, NY
3	07/30-08/03/89	X	Rhone-Poulenc, Charleston, WV
	08/14-16/89	X	LCP Chemicals, Inc., Moundsville, WV
	09/11-12/89	X	Purolite Company, Philadelphia, PA
	09/25-26/89	X	Carl Falkenstein, Philadelphia, PA
	01/31 & 02/02/90	X	Automata, Sterling, VA
	02/12-16/90	X	Mobay Chemical, New Martinsville, WV
	03/26-28/90	X	Olin Chemical, Charleston, WV
	08/20-22/90	X	Occidental Chemicals, Delaware City, DE
	01/07-10/91	X	Rohm & Haas, Bristol, PA
	04/15-16/91	X	Anzon Lead, Philadelphia, PA
	04/23-25/91	X	DuPont Textile Fibers, Waynesboro, VA
	05/21-23/91	X	SCM Chemicals, Baltimore, MD
	11/19-22/91	X	Vista Chemicals, Baltimore, MD
	02/03-07/92	X	Allied-Signal, Hopewell, VA
	04/27-29/92	X	BP Oil Refinery, Marcus Hook, PA
	07/07-10/92	X	Huntsman Chemical Corp., Chesapeake, VA
	07/28-29/92	X	Beatrice Cheese, Whitehall, PA
	11/09-11/92	X	Allied-Signal, Philadelphia, PA
	01/12-14/93	X	Weirton Steel, Weirton, WV
	03/09-11/93	X	Koppers Industries, Follansbee, WV
	05/18-20/93	X	Merck and Company, Riverside, PA
	06/22-23 & 07/14 1993	X	Konsyl/Trinity, Easton/Salisbury, MD
	09/27-29/93	X	Allied-Signal BF_3 Plant, Marcus Hook, PA
	11/03-05/93	X	Hoechst Celanese, Narrows, VA
	02/23-24/94	X	Jones Chemicals, Milford, VA
	04/06-08/94	X	GE Specialty Chemicals, Morgantown, WV
	04/20-22/94	X	PPG Industries, New Martinsville, WV
	05/11-13/94	X	Armstrong World Industries, Lancaster, PA
	06/01-03/94	X	Carpenter Technology, Reading, PA
	09/19-21/94	X	Union Camp, Franklin, VA
	11/11-13/94	X	Air Products and Chemicals, Hometown, PA
	01/10-11/95	X	Standard Chlorine, Delaware City, DE
	02/06-08/95	X-D	Sunoco Girard Point, Philadelphia, PA
	02/14-16/95	X	Blue Plains WWTP, Washington, DC
	07/11-13/95	X-D	Cytec Industries, Willow Island, WV
4	03/20-24/89	X	Royster Phosphate, Piney Point, FL
	05/01-05/89	X	Olin Corporation, Charleston, TN
	07/11/89 & 08/03-04/89	X	Armco Steel, Ashland, KY
	07/18-20/89	X	Kerr McGee, Hamilton, MS
	08/17/89 & 09/11-15/89	X	Texas Gulf, Aurora, NC
	02/12-13/90	X	Photocircuits Atlanta, Peachtree City, GA
	02/26-03/02/90	X	Kemira, Savannah, GA
	04/04-05/90	X	Astrotech, Titusville, FL
	05/08-11/90		**Cardinal Chemical Co., Columbia, SC**
	09/11-13 & 24-27/90	X	Tennessee Chemical Co., Copper Hill, TN
	10/26/90	X	Kason Industries, Newnan, GA

REGION	DATE OF AUDIT	REPORT STATUS	NAME OF FACILITY
	11/29/90	X	C & S Chemical Company, Austell, GA
	12/4-5/90	X	Carolina Solite, Norwood, NC
	12/4-5/90	X	Oldover Corporation, Albemarle, NC
	12/12/90	X	Tull Chemical Company, Oxford, AL
	01/07-10/91	X	Peridot Chemical Company, Augusta, GA
	01/22-25/91	X	Aqua Tech/Groce Labs, Duncan, SC
	01/30-31/91	X	Virtex Chemicals, Bristol, TN
	02/20-21/91	X	Water Treatment Plant, Cape Coral, FL
	02/25-26/91	X	Canal Pumping Station, Cape Coral, FL
	03/04-08/91	X	Kentucky American Water, Lexington, KY
	03/19/91	X	Drexel Chemical Co., Tunica County, MS
	03/27/91	X	Columbia Organics, Camden, SC
	04/02/91	X	Armstrong Glass, Atlanta, GA
	08/26-29/91	X	B. F. Goodrich, Calvert City, KY
	11/12-14/91	X	West Lake Monomers, Calvert City, KY
	01/21-24/92	X-ND	Piney Point Phosphates, Piney Point, FL
	03/24-26/92	X	Reichold Chemicals, Kensington, GA
	04/28-05/01/92	X	G.E. Lighting Systems, Hendersonville, NC
	07/20-21/92	X	Jones Chemicals, Charlotte, NC
	08/25-26/92	X-ND	Peridot Chemical Company, Augusta, GA
	08/03-07/92	X	Velsicol Chemicals, Chattanooga, TN
	11/16-20/92	X	Mississippi Chemicals, Yazoo City, MS
	01/04-08/93	X	DuPont, Louisville, KY
	02/01-02/93	X	IMC Fertilizer, Tampa, FL
	02/02-03/93	X	Seminole Fertilizer, Tampa, FL
	02/04-05/93	X	CF Industries, Tampa, FL
	03/29-04/02/93	X	Jones Chemicals, Mobile, AL
	03/29-04/02/93	X	Occidental Chemicals, Mobile, AL
	07/12-13/93	X	Trojan Battery, Lithonia, GA
	08/02-06/93	X	Ciba-Geigy, McInstosh, AL
	11/29-12/02/93	X	High Point Chemicals, High Point, NC
	12/07-08/93	X	Grady Hospital, Atlanta, GA
	01/11-13/94	X	Albright and Wilson, Charleston, SC
	02/07-11/94	X	Sherwin-Williams, Richmond, KY
	04/05-06/94	X	Allied Universal, Leesburg, FL
	04/15-29/94	X	First Chemical Corporation, Pascagoula, MS
	04/26-28/94	X	Witco Corporation, Memphis, TN
	07/11-15/94	X	General Electric, Burkville, AL
	10/17/94	X	Ashland Petroleum, Ashland, KY
	11/01-03/94	X	Holox Limited, Union City, GA
	11/14-18/94	X	Tennessee Eastman, Kingsport, TN
	12/12-15/95	X	Union Carbide Corporation, Tucker, GA
	01/24-27/95	X	PCR, Gainesville, FL
	01/30-02/03/95	X	Scott Paper Company, Mobile, AL
	04/17-21/95	X	Henkel Corporation, Charlotte, NC
	06/04-09/95	X	Arcadian Fertilizer, Augusta, GA
	06/19-23/95	X	American Synthetic Rubber, Louisville, KY
	11/27-12/01/95	X	Degussa Corporation, Theodore, AL
	02/12-16/96	X-R	Vicksburg Chemical Company, Vicksburg, MS
	02/13-15/96	X-R	Gilman Paper Company, St. Marys, GA

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	04/15-19/96	X-R	CONDEA Vista, Aberdeen, MS
	07/15-19/96	X-R	Vinings Industries, Marietta, GA
	11/18-22/96	X-R	Great Lakes Chemical, Newport, TN
	02/10-14/97	X-R	Riverwood International, Macon, GA
	03/17-21/97	X-R	Platte Chemical Corporation, Greenville, MS
	05/05-09/97	X-R	MAPCO, Memphis, TN
	09/22-26/97	X-R	Halocarbon Products, North Augusta, SC
	11/03-07/97	X-R	DuPont Fluoroproducts, Louisville, KY
	11/14/97	X-R	Sony Music, Carrollton, GA
	01/12-16/98	X-R	NIPA Hardwicke, Elgin, SC
	02/09-13/98	X-R	Shell Chemical, Mobile, AL
	07/20-23/98	X-R	Eastman Chemicals, Eastman, South Carolina
5	07/25-28/89	X	Koppers, Cicero, IL
	08/08-11/89	X	Best Foods, Chicago, IL
	09/15/89	X-D	Shell Oil, Wood River, IL
	03/05/90	X-D	Eli Lilly, Clinton, IN
	03/26-30/90	X-D	Anderson Development, Adrian, MI
	04/14-18/90	X	General Electric Plastics, Mt. Vernon, IN
	06/11-15/90	X-D	Tremco, Inc., Cleveland, OH
	07/16-19/90	X-D	Flexel, Inc., Covington, IN
	03/18-20/91	X	Detroit Edison, River Rouge, MI
	05/20-22/91	X	Nalco Chemical Company, IL
	08/12-14/91	X	SCM Chemicals, Ashtabula, OH
	03/10-12/92	X	Elf Atochem, Riverview, MI
	04/21-23/92	X	BASF Corporation, Wyandotte, MI
	06/02-04/92	X	G.E. Superabrasives, Worthington, OH
	11/03-05/92	X	Yenkin-Majestic Paints, Columbus, OH
	12/15-17/92	X	Allison Gas Turbine, Indianapolis, IN
	04/13-15/93	X	Lomac Corporation, Muskegon, MI
	06/15-17/93	X	Specialty Chem, Marinette, WI
	07/20-21/93	X	Witco, Chicago, IL
	08/17-18/93	X	Interplastic, Minneapolis, MN
	03/29-31/94	X	Upjohn Company, Portage, MI
	08/31-09/01/94	X	Stepan Company, Elwood, IL
	10/11-12/94	X	Farley Company, Brimfield, OH
	02/21-23/95	X	Capital Resin Corporation, Columbus, OH
	05/02-04/95	X	Clark Refining and Marketing, Blue Island, IL
	06/06-08/95	X	Spectrulite Consortium, Madison, IL
	08/15-17/95	X	Waldorf Corporation, St. Paul, MN
	07/09-11/96	X-D	Hydrite Chemical, Oshkosh, WI
	09/22-24/96	X-D	ISP Fine Chemicals, Columbus, OH
6	06/13/89	X	Western Extrusion, Carrollton, TX
	08/30-31/89	X	Great Lakes Chemical Co., El Dorado, AR
	08/15-16/89	X	Farmland Industries, Enid, OK
	09/12-13/89	X	Fermenta ASC Corporation, Houston, TX
	10/16-17/89	X	Chief Supply, Haskell, OK
	11/06-07/89	X	Phillips Petroleum, Pasadena, TX
	11/14/89	X	Texas Instruments, Dallas, TX

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	01/17-18/90	X	Exxon Refinery, Baton Rouge, LA
	04/17-19/90	X	Olin Chemicals, Lake Charles, LA
	03/05-06/91	X	Sid Richardson Carbon Co., Borger, TX
	03/20-22/91	X	ARCO Chemical, Channelview, TX
	05/01-03/91	X	Citgo Refinery, Lake Charles, LA
	07/09-11/91	X	International Paper, Pine Bluff, AR
	08/27-29/91	X	Agricultural Minerals, Catoosa, OK
	02/25-26/92	X	Safety-Kleen Corporation, Denton, TX
	06/09-10/92	X	Halliburton Services, Caldwell, TX
	08/17-18/92	X	Houston Woodtech, Houston, TX
	08/24/92	X	Allied-Signal, Geismar, LA
	11/17-18/92	X	CPS Chemicals, West Memphis, AR
	03/16-17/93	X	Labbco, Inc., Slidell, LA
	08/31-09/03/93	X	Chevron USA, El Paso, TX
	09/08-09/93	X	Harcros Chemicals, Dallas, TX
	10/05-07/93	X	Ethyl Corporation, Magnolia, AR
	12/14-15/93	X	Champion Technologies, Odessa, TX
	06/07-09/94	X	Phillips 66, Borger, TX
	08/23-25/94	X	Sterling Chemicals, Texas City, TX
	11/01/94	X	Creamland Dairies, Albuquerque, NM
	11/02/94	X	DPC Industries, Albuquerque, NM
	11/15-17/94	X	Navajo Refining Company, Artesia, NM
	08/22-25/95	X-D	Formosa Plastic, Point Comfort, TX
7	10/25/90	X	ICI Americas, Omaha, NE
	11/20/90	X	Jacobson Warehouse, Des Moines, IA
	05/01/91	X	ABB Power Transformers, St. Louis, MO
	07/31/91	X	Hydrozo, Inc., Lincoln, NE
	12/04/91	X	Rhone-Poulenc, Sedalia, MO
	05/06-07/92	X	American Cyanamid, Hannibal, MO
	06/15-16/92	X	Proctor and Gamble, Kansas City, KS
	06/22-23/92	X	Hercules Aqualon Company, Louisiana, MO
	07/15/92	X	Cotter and Company, Kansas City, MO
	08/17-18/92	X	Cornbelt Chemical Company, McCook, NE
	08/31/92	X	Eagle Lithographing, Kansas City, MO
	09/03/92	X	Independence WWTP, Sugar Creek, MO
	09/30/92	X	Flexel, Inc., Tecumseh, KS
	12/16/92	X	Arcadian Fertilizer, Clinton, IA
	12/18/92	X	Rock Creek WWTP, Independence, MO
	04/26/93	X	Rhone-Poulenc AG, St. Louis, MO
	05/13/93	X	LaRoche Industries, Crystal City, MO
	05/11/93	X	Golden Valley Cheese, Clinton, MO
	06/03/93	X	Total Petroleum, Arkansas City, KS
	06/29/93	X	Farmland Petroleum, Coffeyville, KS
	07/08/93	X	AG Processing, Eagle Grove, IA
	07/21/93	X	Farmland Industries, Lawrence, KS
	07/29/93	X	Beech Aircraft, Wichita, KS
	08/05/93	X	Ralph Green Plant, Pleasant Hill, MO
	10/11/93	X	Whitmire Research Lab, Valley Park, MO
	10/12/93	X	Doe Run Company, Herculaneum, MO
	11/09/93	X	Ecolab Pest Elimination, Kansas City, MO

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	11/30/93	X	Carmar Group, Carthage, MO
	01/13/94	X	Cook Composites, N. Kansas City, MO
	02-05/94	X	Van Waters and Rogers, St. Louis, MO
	02/11/94	X	Wells' Dairy, Le Mars, IA
	02/15-07/18/94	X	3M, Springfield, MO
	02/17/94	X	Armour Swift-Eckrich Plant, Kansas City, MO
	02/28/94	X	Terra International, Sergeant Bluff, IA
	04/19/94	X	Seitz Foods, St. Joseph, MO
	04/28/94	X	Fleming Foods, Sikeston, MO
	05/04-06/94	X	Mallinckrodt Chemicals, St. Louis, MO
	06/22/94	X	Meadow Gold Dairies, Des Moines, IA
	06/23/94	X	3M Commercial Graphics, Nevada, MO
	07/08/94	X	ICI Explosives, Joplin, MO
	09/15/94	X	BioKyowa, Cape Girardeau, MO
	09/29-30/94	X	Elf Atochem, Wichita, KS
	11/08/94	X	IES Industries, Marshalltown, IA
	11/10/94	X	Dyno-Nobel, Louisiana, MO
	11/28/94	X	Vulcan Chemicals, Wichita, KS
	12/30/94	X	Chemcentral, Maryland Heights, MO
	12/31/94	X	Hudson Foods, Noel, MO
	01/17/95	X	Nat. Coop. Refinery Assoc., McPherson, KS
	01/31/95	X	St. Louis Water Company, Florissant, MO
	02/09/95	X	Howard Bend WWTP, Chesterfield, MO
	03/28/95	X	Chemtech, Kansas City, MO
	05/08/95	X	Douglas Battery, N. Kansas City, MO
	05/12/95	X	Slay Bulk Terminals, St. Louis, MO
	06/13/95	X	Extrusions, Fort Scott, KS
	06/16/95	X	Philip Environmental, Kansas City, MO
	07/14/95	X-R	Wagner Brake, Berkeley, MO
	09/14/95	X	Foamex, Cape Girardieu, MO
	02/12/96	X-R	Siegwerk, Inc., Greenfield, IA
	04/09/96	X-R	Koch Sulfur Products, DeSoto, KS
	08/08/96	X-R	General Motors, Kansas City, KS
	11/04/96	X-R	Owens-Corning, Kansas City, KS
	11/08/96	X-R	Tyson Foods, Monett, MO
	12/13/96	X-R	Copeland Corporation, Lebanon, MO
	01/29/97	X-R	United Refrigeration Services, Wichita, KS
	10/02/97	X-R	Agrium Homestead Nitrogen, Beatrice, NE
	10/07/97	X-R	Morton International, Hutchinson, KS
	02/10/98	X-R	Reames Foods, Clive, IA
	08/05/98	X-R	LaRoche Industries, Crystal City, MO
8	05/02-04/89	X	Phillips Refinery, West Bountiful, UT
	06/13-15/89	X	Chevron Chemical, Rock Springs, WY
	08/15-17/89	X	Western Forge, Colorado Springs, CO
	03/27/90	X	Koppers Industries, Denver, CO
	05/15-17/90	X	Amoco Production Company, Powell, WY
	06/26-29/90	X	Amoco Casper Refinery, Casper, WY
	08/27-31/90	X	Western Zirconium, Ogden, UT
	11/01/90	X	Jemm Plating, Co., Denver, CO

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	02/06-07/91	X	SAS Circuits, Littleton, CO
	02/19-21-91	X	Kodak-Colorado Division, Windsor, CO
	04/30-05/03/91	X	Col. Falls Aluminum, Columbia Falls, MT
	05/29-31/91	X	Syncom Techologies, Mitchell, SD
	09/29-30/91	X	LaRoche Industries, Orem, UT
	11/12-13/91	X	T.G. Soda Ash, Granger, WY
	02/18-20/92	X	Coastal Chemical, Cheyenne, WY
	02/25-27/92	X	Chevron Refinery, Salt Lake City, UT
	05/27-29/92	X	Rhone-Poulenc, Butte, MT
	08/18-19/92	X	ALCHEM, Ltd., Grafton, ND
	02/09-12/93	X	Stone Container Corp., Missoula, MT
	05/18-21/93	X	Magnesium Corp., Salt Lake City, UT
	06/15-18/93	X	Frontier Refining, Cheyenne, WY
	09/08-10/93	X	Koch Sulfur Products, Riverton, WY
	03/01-04/94	X	Dakota Gasification, Mercer County, ND
	05/03-06/94	X	John Morrell, Sioux Falls, SD
	06/07-10/94	X	Huish Detergents, Salt Lake City, UT
	09/13-15/94	X	Montana Refining, Great Falls, MT
	07/10-14/95	X-D	Coors Brewing Company, Golden, CO
	08/29-31/95	X-D	Anheuser Busch Brewer, Fort Collins, CO
	09/18-21/95	X-D	Sinton Dairy Foods, Colorado Springs, CO
9	05/12-13/89	X	Nunes Cooling, Salinas, CA
	07/25-27/89	X	Unocal Chemical, Brea, CA
	08/16-17/89	X	Eticam of Nevada, Fernley, NV
	09/07-08/89	X	Coronado Generator, St. Johns, AZ
	04/17-20/90	X	Ultramar Refinery, Wilmington, CA
	06/19-22/90	X	Magma Copper, San Manuel, AZ
	07/17-20/90	X	Pioneer Chlor-Alkalai, Henderson, NV
	09/10-16/90	X	Dole Packaged Foods, Honolulu, HI
	04/09-12/91	X	Motorola, Phoenix, AZ
	07/16-19/91	X	Dow Chemicals, Pittsburg, CA
	08/20/91	X-ND	Pioneer Chlor-Alkalai, Henderson, NV
	08/21-23/91	X	Timet Corporation, Henderson, NV
	02/11-14/92	X	Brewer Environmental Services, Honolulu, HI
	06/08/92	X	General Chemical Corporation, Pittsburg, CA
	07/14-17/92	X	Chevron Refinery, Richmond, CA
	08/24-27/92	X	Shell Oil Refinery, Martinez, CA
	02/23-24/93	X	Brewer Environmental Services, Honolulu, HI
	05/04-05/93	X	Union Pacific Railroad, Stockton, CA
	07/27-30/93	X	Louisiana Pacific Pulp Mill, Samoa, CA
	04/12-15/94	X	ATSF Rail Yard, Barstow, CA
	07/19-21/94	X	General Chemical Corporation, Pittsburg, CA
	10/06-08/94	X	Kerley Ag, Antioch, CA
	12/05-08/94	X	Southern Pacific Lines, Long Beach, CA
	08/14-15/95	X-D	Pimalco, Chandler, AZ
	08/16/95	X-D	Solkatronic Chemical, Chandler, AZ
	08/05-09/96	X-ND	Puna Geothermal Venture, Hawaii
10	07/27/89	X	All Pure Chemical Company, Kalama, WA

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	08-10/89	X	ITT Rayonier, Port Angeles, WA
	09/12-15/89	X	McWhorter Northwest, Portland, OR
	03/19-23/90	X	BP Oil Company, Ferndale, WA
	04/23-27/90	X	FMC Corporation, Pocatello, ID
	05/14-18/90	X	Neste Resins, Springield, OR
	09/24-28/90	X	Unocal Chemicals, Kenai, AK
	01/08/91	X	Occidental Chemicals, Tacoma, WA
	01/15-18/91	X	Chevron USA, Seattle, WA
	03/18-22/91	X	James River Corporation, Clatskanie, OR
	04/22-26/91	X	Potlatch Corporation, Lewiston, ID
	07/23-26/91	X	Great Western Chemical Co., Nampa, ID
	08/05-09/91	X	Boise Cascade Mill, Wallula, WA
	02/24-28/92	X	Georgia-Pacific Paper Division, Toledo, WA
	03/23-27/92	X	SEH America, Vancouver, WA
	04/28-05/01/92	X	Amalgamated Sugar Company, Twin Falls, ID
	07/27-31/92	X	ALCOA, Wenatchee, WA
	11/16-20/92	X	Weyerhauser Company, Springfield, OR
	01/25-29/93	X	Wacker Siltronics, Portland, OR
	04/12-16/93	X	Ponderay Newsprint, Usk, WA
	07/26-27/93	X	Darigold, Caldwell, ID
	07/28-29/93	X	Simplot, Caldwell, ID
	10/25-29/93	X	Unocal, Kennewick, WA
	02/14-17/94	X	Boise Cascade, Medford, OR
	03/22-25/94	X	Ocean Spray, Markham, WA
	06/20-24/94	X	Elf Atochem, Portland, OR
	11/14-15/94	X	Southern Oregon Marine, Coos Bay, OR
	11/16/94	X	South Coast Lumber, Brookings, OR
	02/27-03/03/95	X	Georgia-Pacific, Bellingham, WA
	06-05-09/95	X	American Microsystems, Pocatello, ID
	11/13-17 and 12/11-13/95	X-D	Kalama Chemical, Kalama, WA
	04/08-11/96	X-D	Blount International, Lewiston, ID
	07/08-11/96	X-D	Fujitsu Microelectronics, Gresham, OR

Notes:

1. "X" indicates that the final report has been received, and the profile has been entered into the database.

2. "X-R" indicates that the final report and the profile has been received, and the profile will be finalized.

3. "X-D" indicates that only the final report has been received, and the profile will be developed and completed.

4. "X-ND" indicates that the final report has been received, but no profile will be prepared because the audit was a follow-up visit, rather than a new audit.

5. **Bold** text indicates that the final report has not yet been received.

6. The audit conducted by Region 10 at ITT Rayonier in Port Angeles, WA, occurred over a period of several months.