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United States
Environmental Protection
Agency

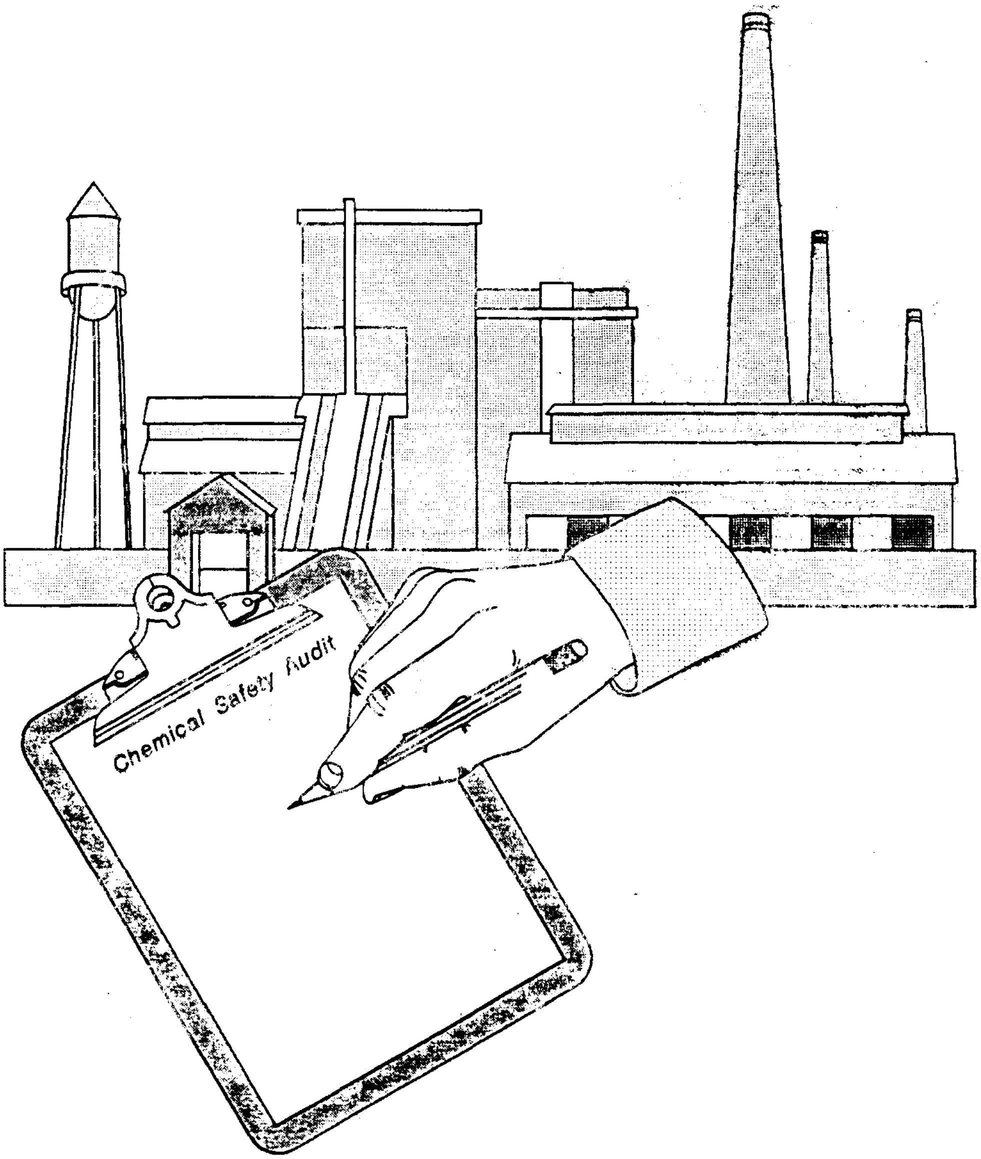
Office of Emergency and
Remedial Response
Emergency Response Division

Environmental
Response
Team

EPA

Chemical Safety Audits

Environmental Response Training Program



FOREWORD

This manual is for reference use of students enrolled in scheduled training courses of the U.S. Environmental Protection Agency (EPA). While it will be useful to anyone who needs information on the subjects covered, it will have its greatest value as an adjunct to classroom presentations involving discussions among the students and the instructional staff.

This manual has been developed with a goal of providing the best available current information; however, individual instructors may provide additional material to cover special aspects of their presentations.

Because of the limited availability of the manual, it should not be cited in bibliographies or other publications.

References to products and manufacturers are for illustration only; they do not imply endorsement by EPA.

Constructive suggestions for improvement of the content and format of the manual are welcome.

U.S. Environmental Protection Agency
Office of Emergency and Remedial Response
Environmental Response Team

CHEMICAL SAFETY AUDITS

(165.19)

4 Days

This course introduces safety auditing for highly hazardous chemicals and is based on the U.S. Environmental Protection Agency's (EPA) Chemical Safety Audit Program and the Occupational Safety and Health Administration's (OSHA) Process Safety Management (29 CFR 1910.119). The course covers basic chemical systems and processes, chemical process hazards, process safety systems, process safety management, emergency response, chemical hazard mitigation, chemical hazard evaluation, hazard evaluation techniques, and incident (hazardous material release) investigation. Interviewing techniques, computer modeling, and report writing are also covered.

Participants receive practical auditing experience by forming an audit team and conducting a mock chemical safety audit at a fictitious chemical plant. The mock audit follows protocol established in EPA's *Guidance Manual for EPA Chemical Safety Audit Team Members*.

This introductory course provides an overview of chemical process safety and chemical safety auditing. Participants responsible for reviewing emergency response and safety programs at chemical plants, petrochemical plants, refineries, or chemical storage facilities in their area of responsibility will benefit from this course.

After completing this course, participants will be able to:

- Describe EPA's Chemical Safety Audit Program.

- Describe chemical processes, process hazards, process safety systems, safety management, emergency response, hazards evaluation, and incident investigation in process plants.

- Discuss interviewing, computer modeling, and report-writing techniques.

- List the required and suggested activities covered in the *Guidance Manual for EPA Chemical Safety Audit Team Members*.

- Perform a chemical safety audit using EPA protocol, interviewing techniques, and report-writing skills.

After completing this course, participants will be more familiar with chemical processes, hazards, hazard evaluation, the EPA chemical safety audit process, and EPA auditing protocol.

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FACT SHEET MARCH 1993

CHEMICAL SAFETY AUDIT PROGRAM

BACKGROUND

The Chemical Safety Audit (CSA) program has evolved from the efforts of the U.S. Environmental Protection Agency (EPA) under the Chemical Accident Prevention (CAP) program. The CAP program emerged from concerns raised by the release of methyl isocyanate at Bhopal, India, and of aldicarb oxime at Institute, West Virginia. Awareness of the critical threat to public safety posed by similar incidents led to an emphasis on preparedness and planning for response to chemical accidents. Simultaneous with the development of preparedness activities by EPA was the passage and implementation of the Emergency Planning and Community Right-to-Know Act -- Title III of the Superfund Amendments and Reauthorization Act (SARA) by Congress in 1986. Because prevention is the most effective form of preparedness, the CAP program promotes an effort to enhance prevention activities. The primary objectives of the CAP program are to identify the causes of accidental releases of hazardous substances and the means to prevent them from occurring, to promote industry initiatives in these areas, and to share activities with the community, industry, and other groups.

Many of the key concerns of the CAP program arise from the SARA Title III section 305(b) study entitled Review of Emergency Systems. As part of the information gathering efforts to prepare this study, EPA personnel conducted a number of facility site visits to learn about chemical process safety management practices. The study covers technologies, techniques, and practices for preventing, detecting, and monitoring releases of extremely hazardous substances, and for alerting the public to such releases. One of the key recommendations resulting from the study was the continuation and expansion of the audit program.

As a follow-up to this national prevention study, EPA has undertaken cooperative initiatives with federal agencies, states, industry groups, professional organizations, and trade associations, as well as environmental groups and academia. These joint efforts will serve to determine and implement a means to share information on release prevention technology and practices, and to enhance the state of practice in the chemical process safety arena.

PROGRAM GOALS

The CSA program is part of this broad initiative and has been designed to accomplish the following chemical accident prevention goals:

- Visit facilities handling hazardous substances to gather information on and learn about safety practices and technologies;
- Heighten awareness of the need for, and promote, chemical safety among facilities handling hazardous substances, as well as in communities where chemicals are located;
- Build cooperation among facilities, EPA, and other authorized parties by coordinating joint audits; and
- Establish a database for the assembly and distribution of chemical process safety management information obtained from the facility audits.

PROGRAM AUTHORITY

The Comprehensive, Environmental Response, Compensation and Liability Act (CERCLA or Superfund) was enacted December 11, 1980, and amended by SARA on October 17, 1986. CERCLA authorizes the federal government to respond where there is a release or a substantial threat of a release into the environment of any hazardous substance, pollutant, or contaminant that may present danger to the public health or welfare or to the environment.

CERCLA Sections 104(b) and 104(e), as amended by SARA in 1986, provide authorities for entering a facility and accessing information to conduct a chemical safety audit by EPA. While CERCLA provides authority for states to use statutory authorities for entry and information gathering, such authorities may only be accessed pursuant to a contract or cooperative agreement with the federal government. Since there is no such arrangement, states, as well as local governments, must use their own authorities for audit participation.

As a matter of EPA policy under the CSA program, all facilities that will receive an audit should have experienced a release of a hazardous substance, pollutant, or contaminant, or there should be reason to believe that there exists a threat of such a release. The audits are intended to be nonconfrontational and positive, such that information on safety practices, techniques, and technologies can be identified and shared between EPA and the facility. Involvement in the CSA program by Local Emergency Planning Committees (LEPCs) and State Emergency Response Commissions (SERCs) formed under SARA Title III is encouraged to enhance the goals of both of these programs. However, as stated above, state and local government participation in the audit, itself, must be performed under state and local authorities.

AUDIT SCOPE

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. Specific topics addressed include:

- Awareness of chemical and process hazards;
- Process characteristics;
- Emergency planning and preparedness;
- Hazard evaluation and release detection techniques;
- Operations and emergency response training;
- Facility/corporate management structure;
- Preventive maintenance and inspection programs; and
- Community notification mechanisms and techniques.

Observations and conclusions from audits are detailed in a report prepared by the audit team. The report identifies and characterizes the strengths of specific Chemical Accident Prevention program areas to allow the elements of particularly effective programs to be recognized. Copies of the report are provided to the facility so that weak and strong program areas may be recognized. The audit is conducted following the Guidance Manual for EPA Chemical Safety Audit Team Members, issued by EPA Headquarters. This guidance contains recommended actions, as well as mandatory procedures that must be followed 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 is transmitted to the audited facility.

AUDIT TEAM COMPOSITION

An EPA audit team primarily consists of EPA employees, and other designated representatives including contractors and the American Association of Retired Persons (AARP) enrollees. Other federal, state, and local government personnel may also be team members. The audit team can vary in size, depending upon the level of detail of the audit (e.g., number of chemicals and/or processes under investigation; national significance).

FACILITY SELECTION

At present, there are no established procedures for selecting a facility for an audit. Each EPA region has flexibility in identifying facilities. Options to consider in selecting a facility include:

- Previous history of the facility;
- SERC and/or LEPC referral;
- Proximity to sensitive population(s);
- Public sensitivity;
- Regional accident prevention initiatives;
- Opportunity for sharing new technology;
- Population density; and
- Concentration of industry in the area.

REPORT DISTRIBUTION

Standard distribution by EPA regional offices of the audit report will be at a minimum to:

- SERC and LEPC in which the facility is located;
- Facility owner/operator and facility CEO;
- EPA Headquarters; and
- Any other federal, state, and local agencies or departments that assisted in conducting the audit.

Distribution is available to other EPA offices, other federal, state, and local agencies or departments, and other private and public sector organizations.

ACCOMPLISHMENTS

During the first four years of the CSA program, the regions have conducted audits at over 150 facilities in 46 states and Puerto Rico. EPA has analyzed the conclusions and recommendations listed in the audit reports to identify trends within and across industries, processes, and chemicals to assist in the further development of the CSA and CAP programs, particularly in light of the accidental release provisions of section 112(r) of the Clean Air Act. At the same time, follow-up activities performed by several of the regional offices indicate that the majority of the recommendations to improve chemical process safety practices suggested by the audit teams have been implemented or are scheduled to be implemented at audited facilities.

CSA PROGRAM BENEFITS

- Identification of effective, field-proven chemical accident prevention technologies and practices.

- Better understanding of the causes of chemical releases.

- Greater awareness by facilities of chemical safety and understanding of available techniques, and specific suggestions for improved programs.

- Identification of problem areas in industry where more attention is needed.

- Cooperation and coordination of chemical safety programs with other federal and state agencies through joint audits and training.

For more information on the Chemical Safety Audit program, contact the Chemical Emergency Preparedness Program (CEPP) office in your EPA regional office.

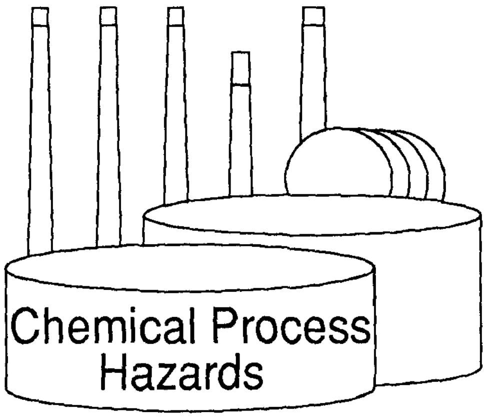
CHEMICAL PROCESS HAZARDS

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe chemical process hazards, including:
  - Overpressurization
  - Loss of flow
  - High level
  - High temperature
  - Improper mixing
  - Loss of containment.

NOTES



CHEMICAL HAZARDS

- Flammability
- Explosivity
- Radioactivity

CHEMICAL HAZARDS (cont.)

- Reactivity
- Corrosivity
- Toxicity

NOTES

PROCESS HAZARDS

- Process variables
- Process operations/design

PROCESS VARIABLES

- Pressure
- Flow
- Level
- Temperature

PRESSURE

- Overpressure
- Underpressure
- Shock/stress - "water hammer"

NOTES

FLOW

- Fluctuating flow
- Overflow
- Underflow
- Reversed flow

LEVEL

- Overfilling
- Underfilling

TEMPERATURE

- High temperature
- Low temperature

NOTES

PROCESS OPERATION/DESIGN

- Mixing
- Containment
- Design
- Human factors

MIXING

- Uneven mixing
- Loss of agitation
- Vibration

CONTAINMENT
Loss of Containment

- Overfilling tanks
- Pump seal leaks
- Corrosion
- Spills

NOTES

DESIGN

- Utilities failure
- Control system failure
- Underdesign/redesign
- Natural disasters

HUMAN FACTORS

- Human error
- Terrorism
- Revenge

AUDIT TEAM PERSPECTIVE

- What hazards does the facility recognize?
- What value does the facility place on perceived hazards?
- How does the facility manage hazards?

PROCESS SAFETY MANAGEMENT

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe EPA's and industry's responses to major chemical releases that occurred in the past
- List the key elements of industry's chemical process safety management system
- Describe EPA's role in chemical process safety management.

NOTES

PROCESS SAFETY MANAGEMENT

CHEMICAL PROCESS SAFETY MANAGEMENT

- Chemical process safety
- Chemical process safety management
- EPA's role

CHEMICAL PROCESS SAFETY

Operation of facilities handling hazardous materials in a manner free from episodic or catastrophic incidents

NOTES

MAJOR INCIDENTS

- Fixborough, England (1974)
- Mexico City, Mexico (1984)
- Bophal, India (1984)

MAJOR INCIDENTS (cont.)

- Chernobyl, USSR (1986)
- Shell Norco Refinery, USA (1988)
- Phillips Petroleum Refinery, USA (1989)

EPA RESPONSE TO MAJOR INCIDENTS

- Chemical Emergency Preparedness Program (1985)
- SARA Title III (1986)

NOTES

EPA RESPONSE TO MAJOR INCIDENTS (cont.)

- Clean Air Act (1988)
  - Review of emergency systems
  - Section 305(b)
  - Accidental Release Information Program

INDUSTRY'S RESPONSE

- Community Awareness and Emergency Response program (CAER)
- Center for Chemical Process Safety

CHEMICAL PROCESS SAFETY MANAGEMENT

Management systems to identify, understand, and control process hazards to prevent incidents and injuries

NOTES

KEY ELEMENTS

- Management philosophy and goals
- Process knowledge
- Design

KEY ELEMENTS (cont.)

- Process risk management
- Management of change
- Process and equipment integrity

KEY ELEMENTS (cont.)

- Emergency preparedness and planning
- Human factors
- Training

NOTES

KEY ELEMENTS (cont.)

- Incident investigation
- Standards, codes, and laws
- Audits and corrective action
- Research

ESTABLISHING MANAGEMENT SYSTEMS

- Company policy and goals
- Measures of performance
- Incentives
- Resource commitment

EPA's ROLE

- Act as a catalyst
- Provide guidance
- Provide technical assistance

NOTES

EPA's ROLE (cont.)

- Develop knowledge base
- Encourage industry to improve practices
- Develop a regulatory program (as needed)

CHEMICAL SAFETY AUDIT

MANUAL REVIEW

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe the background and authority for the Chemical Safety Audit program
- Describe EPA policy and procedures relative to:
  - Facility consent or invitation
  - Handling of confidential business information
  - Attorney-client privilege
  - Response actions
  - Relationship of chemical safety auditing to enforcement and compliance with EPA regulatory programs
- Describe the roles and responsibilities of chemical safety audit team members
- List seven actions that are required activities under the EPA chemical safety audit program protocol.

NOTES

CHEMICAL SAFETY AUDIT MANUAL REVIEW

GUIDANCE MANUAL FOR EPA CSA TEAM MEMBERS

Revised June 1993

Purpose

- Provides EPA policies and procedures for implementing the Chemical Safety Audit (CSA) program

GUIDANCE MANUAL FOR EPA CSA TEAM MEMBERS (cont.)

Contents

- Introduction
- Program authority under CERCLA
- Role of audit team members
- Preparing for the audit

NOTES

GUIDANCE MANUAL FOR EPA CSA TEAM MEMBERS (cont.)

Contents

- Conducting the audit
- Audit protocol/report preparation guidance
- Audit follow-up activities

SECTION 1: INTRODUCTION

- Program background and overview
- Required vs. recommended activities
- CSA program fact sheet

SECTION 2: PROGRAM AUTHORITY UNDER CERCLA

- Statutory authority
- Confidential information
- Attorney-client privilege

NOTES

PROGRAM AUTHORITY UNDER CERCLA (cont.)

- Response actions
- Relationship to enforcement/compliance regulatory programs

STATUTORY AUTHORITY

- CERLCA Sections 104(b) and 104(e) as amended by SARA in 1986
- Authority to EPA and designated representatives
- Authority not applicable to other federal agencies and departments or state and local governments

CONFIDENTIAL INFORMATION

- Facilities can claim that information is confidential under CERCLA Section 104(e)
- EPA employees and authorized representatives can access and view confidential business information under CERCLA

NOTES

ATTORNEY-CLIENT PRIVILEGE

- Facility may withhold information based on attorney-client privilege
- Procedures to follow
  - Continue audit unless absence of requested information makes it impossible to do so
  - Contact EPA's Office of Regional Counsel (ORC)

ATTORNEY-CLIENT PRIVILEGE (cont.)

- Procedures to follow
  - Provide ORC with
    - Name of document(s) withheld
    - Reason why document was withheld
    - Facility attorney, address, and telephone number

RESPONSE ACTIONS

- If threat of release is observed during audit, the following actions must be taken:
  - Regroup the team
  - Inform facility
  - If facility fails to appropriately respond, contact the Regional Response Center to determine scope of action

NOTES

RESPONSE ACTIONS (cont.)

- If release occurs at a facility:
  - Follow facility procedures for protection
  - When and if appropriate, contact National and/or Regional Response Center

ENFORCEMENT/COMPLIANCE REGULATORY PROGRAMS

- EPA CSA is not an enforcement or compliance inspection
- Findings and recommendations are not mandatory
- Observed violations should be referred to the respective program office for further action

ROLE OF AUDIT TEAM MEMBERS

- Audit team composition
- Training and safety requirements
- Non-EPA audit team participation
- Liability
- Conflict of interest

NOTES

AUDIT TEAM COMPOSITION

- Team composition considerations
  - Size (3 - 6 members)
  - Expertise

AUDIT TEAM COMPOSITION (cont.)

- Sample team
  - Team leader
  - Deputy team leader
  - Chemical process hazards reviewer

AUDIT TEAM COMPOSITION (cont.)

- Sample team
  - Chemical accident prevention reviewer
  - Safety and training reviewer
  - Emergency planning and response reviewer

NOTES

AUDIT TEAM COMPOSITION (cont.)

- Expertise and responsibilities

  Team leader - leads site visit, including logistics, team assignments, liaison with facility personnel, and quality assurance of site visit report

AUDIT TEAM COMPOSITION (cont.)

- Expertise and responsibilities

  Deputy team leader - provides logistical support and assumes other responsibilities as directed by the team leader

AUDIT TEAM COMPOSITION (cont.)

- Expertise and responsibilities

  Chemical process hazards reviewer - evaluates chemical hazards, process engineering, and maintenance procedures

NOTES

AUDIT TEAM COMPOSITION (cont.)

- Expertise and responsibilities

  Chemical accident prevention reviewer - evaluates hazard assessment and modeling techniques, release prevention systems, and mitigation systems

AUDIT TEAM COMPOSITION (cont.)

- Expertise and responsibilities

  Safety and training reviewer - evaluates operator safety and worker right-to-know training programs

AUDIT TEAM COMPOSITION (cont.)

- Expertise and responsibilities

  Emergency planning and response reviewer - evaluates facility emergency planning and response procedures

NOTES

AUDIT TEAM COMPOSITION (cont.)

- Select the appropriate mix of skills
  - Process and safety system technologies
  - Operating procedures
  - Training programs
  - Management programs
- Identify specific roles for each team member

AUDIT TEAM COMPOSITION (cont.)

- Team member representatives
  - EPA employees
  - Technical Assistance Team (TAT) members
  - American Association of Retired Persons (AARP) enrollees
  - Other federal, state, and local governments

AUDIT TEAM COMPOSITION (cont.)

- Role of team members
  - *EPA employees* - coordinate audit program and lead audit team
  - *Contractors/TAT* - provide technical support as defined by EPA
  - *AARP enrollees* - provide technical and general support role

NOTES

TRAINING AND SAFETY REQUIREMENTS

Required for EPA team members

- 24- or 40-hour health and safety course, in accordance with EPA Order 1440.2
- Site safety plan
- Annual medical monitoring
- EPA CSA training course

NON-EPA AUDIT TEAM PARTICIPATION

- Other federal, state, and local agencies; State Emergency Response Commission (SERC); and Local Emergency Planning Committees (LEPCs)

NON-EPA AUDIT TEAM PARTICIPATION (cont.)

- Authorized entry under applicable federal, state, or local statutes
- Support role

NOTES

LIABILITY

- Federal employees
  - Federal Employees Liability Reform and Tort Compensation Act of 1988
  - Suit can be brought against the United States government

LIABILITY (cont.)

- Contractors/TAT
  - No coverage for audit activities
- AARP enrollees
  - No provisions currently exist to indemnify AARP enrollees from personal liability
- Non-EPA personnel
  - Require own liability coverage

CONFLICT OF INTEREST

All persons are prohibited from any involvement with an audit if any of the following situations exist:

- Prior interest
- Financial interest
- Prior consultant
- Other

NOTES

SECTION 4: PREPARING FOR THE AUDIT

- Facility selection
- Facility notification
- Facility background information
- Site visit preparation

FACILITY SELECTION

- Basic requirements
  - Any facility that releases a CERCLA hazardous substance, pollutant, or contaminant or any facility at which there is a "reason to believe" that a threat of such a release exists

FACILITY SELECTION (cont.)

- Basic requirements
  - ORC and SERC/state have been consulted to identify any legal actions currently being pursued or anticipated

NOTES

FACILITY SELECTION (cont.)

- Information sources
  - National or Regional Response Center
  - Accidental Release Information Program (ARIP)
  - Emergency Response Notification System (ERNS)

FACILITY SELECTION (cont.)

- Information sources
  - U.S. Coast Guard's Marine Safety Office
  - Federal Emergency Management Agency (FEMA)
  - Occupational Safety and Health Administration (OSHA) and National Institute of Occupational Safety and Health (NIOSH)

FACILITY SELECTION (cont.)

- Information sources
  - SERC
  - LEPCs
  - State and local government referrals
  - Media reports and news clippings

NOTES

FACILITY SELECTION (cont.) Considerations

- One hazardous substance
- Facility type and size
- Demographics
  - Sensitive populations
  - Highly populated areas
  - High concentration of industry

FACILITY SELECTION (cont.) Considerations

- Catastrophic release of national significance
- Facility compliance and release history
- Natural disaster potential
- Public sensitivity

FACILITY NOTIFICATION

- Suggested activities
  - Telephone call to facility
  - Follow-up letter summarizing telephone discussion
  - Preaudit meeting
- Available tools
  - CSA manual
  - Boilerplate letters

NOTES

FACILITY BACKGROUND INFORMATION

- Obtain facility documents
  - Material safety data sheets
  - Facility layout maps
  - Emergency response plans
  - Standard operating procedures
- Contact state and community (e.g., SERC, LEPCs)

SITE VISIT PREPARATION

- Establish scope of audit (specific team member responsibilities)
- Identify health and safety issues
- Establish objectives and agenda for each day

SECTION 5: CONDUCTING THE AUDIT

- Entry
- Opening meeting
- Onsite activities
- Exit briefing

NOTES

ENTRY

- Team arrival at predetermined time and place
- Blank sign-in sheet vs. "waiver" or "visitor release"
- Facility revocation of consent to enter

OPENING MEETING

- Meeting between audit team and key facility personnel
- Meeting agenda includes:
  - Introductions of team and facility personnel
  - Overview of audit purpose and scope
  - Proposed procedures and schedule

ONSITE ACTIVITIES

- Plant tours
- Assignment of specific tasks to interview, review, and observe

NOTES

EXIT BRIEFING

- Meeting with team and facility personnel
- Summary of observations and findings

SECTION 6: AUDIT PROTOCOL/ REPORT PREPARATION GUIDANCE

- Protocol and report format
- Report contents
- Writing the report
- Standard report disclaimer

SECTION 6: AUDIT PROTOCOL/ REPORT PREPARATION GUIDANCE

- Review and finalization procedures
- Report distribution
- Report profile

NOTES

PROTOCOL AND REPORT FORMAT

- Continuity in report preparation
- Detailed guidance on the types of information to review during the audit and what should be present in the final report
- Report format organized for easy access

REPORT CONTENTS

- Facility information
- Chemical and process hazard information
- Chemical accident prevention

REPORT CONTENTS (cont.)

- Accidental release/incident investigation
- Emergency preparedness and planning
- Public alert and notification

NOTES

WRITING THE REPORT
Postvisit Meeting

- Team members
  - Review and edit notes
  - Use report outline to organize notes and delegate writing responsibilities
  - Review observations and findings
  - Determine recommendations

WRITING THE REPORT (cont.)

- Tips on writing style
  - Provide factual, relevant, complete, objective, and clear information
  - Refrain from judgments of adequacy or inadequacy
- Follow-up information
  - Pre-identify audit team member to contact facility to clarify information

STANDARD REPORT DISCLAIMER

- Accompanies all audit reports and follows cover page
- Clarifies time frame, source of report, contents, and limits of contents

NOTES

REVIEW AND FINALIZATION PROCEDURES

- Approve as "Final" by designated EPA official
- Deny access to draft information
  - "DRAFT"
  - "Pre-decisional Document, Not Disclosable Under FOIA"
  - "Do Not Cite or Quote"

REPORT DISTRIBUTION

- Standard distribution includes
  - SERC and LEPC in which the facility is located
  - Facility chief executive officer
  - EPA headquarters
  - Other federal, state, and local agencies that assisted in the audit
- Public document

REPORT PROFILE

- Prepare report profile as shown in Attachments 11 and 12
- Submit profile to EPA headquarters with the final report

NOTES

AUDIT FOLLOW-UP ACTIVITIES

- Approaches
  - Mail worksheets
  - Revisit

- Information required
  - Name and address of facility
  - List of recommendations
  - Schedule of recommendations that have been or will be implemented

AUDIT FOLLOW-UP ACTIVITIES (cont.)

- Information required
  - Rationale for any recommendations that have not been implemented
  - Facility attitude toward audit
  - Successful and problematic audit activities

COMPUTER MODELING

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe the applications of hazardous chemical release modeling programs

- Describe the limitations of hazardous chemical release modeling programs

- Describe, in general, the strengths and limitations of CAMEO, CHARM, and SAFER

- Describe emergency information programs using EIS as an example

- Describe the U.S. EPA Chemical Safety Audit database.

NOTES

COMPUTER MODELING

COMPUTER MODELING

- Applications for computer modeling
- Limitations of modeling
- Popular models
  - Strengths
  - Considerations
- Facility viewpoint on modeling

APPLICATIONS FOR COMPUTER MODELING

- Hazards identification
- Vulnerability analysis
- Risk analysis
- Emergency response planning

NOTES

HAZARDS IDENTIFICATION

- Facility and site data
- Transportation and community data
- Chemical data

VULNERABILITY ANALYSIS

- Modeling releases
- Establishing vulnerability zones
- Running real-time models and simulations

RISK ANALYSIS

- Based on likelihood and severity
- Ranking of hazards
- Handling judgments and concerns

NOTES

EMERGENCY RESPONSE PLANNING

- Assemble hazard, vulnerability, and risk data
- Facilitate community involvement
- Use real-time models and simulations

LIMITATIONS OF MODELING

- General
- Technical

GENERAL LIMITATIONS

- Garbage in - garbage out (GIGO)
- Purchase and setup costs
- Qualifications and training of operators
- Compatibility with other systems

NOTES

TECHNICAL LIMITATIONS

- Meteorology
- Topography
- Physical and chemical properties
- Source strength and time of duration

POPULAR MODELS
Strengths and Limitations

- CAMEO
- CHARM
- SAFER

CAMEO
(NOAA/EPA)

Capabilities

- Chemical and response information
- Modeling and mapping
- Facility and community information
- Reporting and recordkeeping

NOTES

CAMEO (cont.)

Considerations

- Operating cost
- Appropriateness of air model
- Compatibility with other systems

CHARM (Radian Corp.)

Capabilities

- Complex air release model
- Chemical information
- Plume isopleth drawing
- Real-time input

CHARM (cont.)

Considerations

- Map editing only
- Technical expertise required to operate
- Difficulty with complex terrain

NOTES

SAFER
(Dupont)

Capabilities

- Release modeling and tracking
- Material inventory and training

SAFER (cont.)

Considerations

- Difficulty with buoyant cloud releases
- Difficulty with building wake effects

MAINTENANCE AND UPGRADES

- Maintenance
  - Chemical inventories
  - Equipment changes
- Upgrades
  - Real-time applications
  - Multiple users

NOTES

FACILITY VIEWPOINT ON MODELING

- What model(s) have they chosen?
- How well do these models meet their needs?

FACILITY VIEWPOINT ON MODELING (cont.)

- What strengths and limitations are evident?
- What changes (if any) are planned and why?

PROCESS SAFETY: EQUIPMENT

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe the purpose of process safety systems
- Describe the functions of process safety systems designed for prevention and process safety systems designed for mitigation
- Describe instrumentation and control systems and system components
- Describe prevention equipment used for physical separation and containment
- Describe prevention designs used for physical separation and containment
- Describe mitigation equipment used as barriers and emergency shutdown systems
- Describe mitigation designs used as barriers and emergency shutdown systems.

NOTES

PROCESS SAFETY: EQUIPMENT

PROCESS SAFETY

- Safety systems and equipment
- Safety operations

SAFETY SYSTEMS AND EQUIPMENT

Place process systems in a safe condition

- Protect workers
- Protect facility
- Protect environment
- Meet codes, standards, and regulations

NOTES

DESIGN

- Prevention
  - Designed to prevent an accident
- Mitigation
  - Designed to minimize the effects of an accident

PREVENTION

- Instrumentation and control
- Fail-safe components
- Physical separation
- Redundant components
- Containment

INSTRUMENTATION AND CONTROL

- Pneumatic (air operated)
- Electromechanical
- Computer based

NOTES

INSTRUMENTATION AND CONTROL (cont.)

- Sensors
- Position indicators
- Alarms

INSTRUMENTATION AND CONTROL (cont.)

- Safety/relief valves
- Controllers
- Distributed control systems

FAIL-SAFE COMPONENTS

- Explosion-proof switches
- Fail-safe valves
  - Fail open
  - Fail closed
  - Fail as is

NOTES

PHYSICAL SEPARATION

Separated by

- Distance
- Walls
- Doors
- Inert gas

REDUNDANT COMPONENTS

- Backup pumps
- DC (battery) backup for AC controls (essential service systems)

CONTAINMENT

- Double-walled vessels
- Sealed compartments
- Containment walls, berms, and dikes (mitigation)
- Fire seals (mitigation)

NOTES

MITIGATION

- Barriers
- Emergency shutdown systems
- Site selection

BARRIERS

- Flare towers
- Water curtains
- Scrubbers

EMERGENCY SHUTDOWN SYSTEMS

Systems that activate to place a process, a process unit, or an entire facility in the safest possible condition

NOTES

EMERGENCY SHUTDOWN SYSTEMS (cont.)

- Independent from process system
- On-line testing capabilities
- Manual or automatic operation
- Highly reliable

SITE SELECTION

- Proximity to sensitive ecosystems
- Meteorology
- Topography and seismology
- Availability and reliability of utilities

RELATIONSHIP TO CHEMICAL SAFETY AUDITS

- What hazards has the facility identified?
- What actions has the facility taken to prevent or mitigate chemical releases?

PROCESS SAFETY: OPERATIONS

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- List five facets of facility operations that should be reviewed during a chemical safety audit
- List three major sections of standard operating procedures
- Describe the purpose of lockout/tagout, hot work permit, and confined space entry procedures
- Describe the four major steps used in emergency planning.

NOTES

PROCESS SAFETY: OPERATIONS

FACILITY OPERATIONS

- Management
- Operating procedures
- Emergency planning
- Maintenance

MANAGEMENT

- Design control/configuration control
- Control of change
- Information flow
- Safety-conscious culture

NOTES

OPERATING PROCEDURES

- Standard operating procedures
- Availability of materials
- Lockout/tagout
- Confined space entry

STANDARD OPERATING PROCEDURES

- Startup and shutdown
- Loading and unloading
- Normal operations

AVAILABILITY OF MATERIALS

- Procedures
- Piping and instrumentation diagrams (P&IDs)
- Material safety data sheets

NOTES

LOCKOUT/TAGOUT

OSHA 1910.147

- Isolation
- Lockout
- Controlling energy

CONFINED SPACE ENTRY

OSHA 1910.146

- Permit required
- Permit system
- Training
- Hot work permits

EMERGENCY PLANNING

- Preplanned response procedures
- Protective actions
- Drills and exercises
- Accident assessment

NOTES

PREPLANNED RESPONSE PROCEDURES

- Emergency operating procedures
  - Properly integrated
  - Really used
- Notification procedure
- Community involvement

PROTECTIVE ACTIONS

- Shelter
- Evacuation

DRILLS AND EXERCISES

- Tabletop exercises
- Simulations
- Community involvement

NOTES

ACCIDENT ASSESSMENT

- Identification
- Analysis
- Corrective actions

MAINTENANCE

- Maintenance procedures
- Routine testing and inspections
- Preventive maintenance
- Predictive maintenance

AUDIT TEAM PERSPECTIVE

Understand how the process works

- Capacities and design conditions
- Construction materials
- Variables monitored, controlled, and recorded
- Chemical production rates and use rates

NOTES

AUDIT TEAM PERSPECTIVE (cont.)

- Identify prevention and mitigation elements
- Identify possible hazards or hazardous situations

QUESTIONS TO ASK

- What hazards has the facility identified?
- What actions has the facility taken to deal with the hazards?
- Why has the facility taken the actions?

QUESTIONS TO ASK (cont.)

- What effective safety measures are used by the facility?
- Are there any possible improvements?
  - From other facilities?
  - From observations during the audit?

HAZARD AND RELEASE MITIGATION

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe how hazard and release mitigation are taken into account for each of the following:
  - Compatibility
  - Warning signs and labels
  - Facility layout
- List four ways of reducing hazardous materials in a chemical plant
- List eight types of equipment used in chemical plants to mitigate hazards and releases
- List five operational activities that are examples of proactive hazard mitigation

NOTES

HAZARD AND RELEASE MITIGATION

HAZARD AND RELEASE MITIGATION

- Facility design
- Hazardous materials reduction
- Mitigation equipment
- Mitigation operations
- Areas for review

FACILITY DESIGN

- Compatibility
  - Equipment and process chemicals
  - Equipment and process conditions
  - Process chemicals with each other
  - Replacement parts

NOTES

FACILITY DESIGN (cont.)

- Warning signs and labels
  - Hazards clearly marked
  - NFPA fire diamond and HMIS
  - Color coding

FACILITY DESIGN (cont.)

- Facility layout
  - Separation
  - Isolation
  - Sensitive populations

HAZARDOUS MATERIALS REDUCTION

- Reduce inventories
  - Raw materials
  - Finished products
  - Shipping and receiving

NOTES

HAZARDOUS MATERIALS REDUCTION (cont.)

- Reduce transfers
  - Small or large releases
  - Aggregate or bulk storage

HAZARDOUS MATERIALS REDUCTION (cont.)

- Substitute less hazardous chemicals
- Reduce hazardous chemical concentration

MITIGATION EQUIPMENT

- Alarms
  - Alert; follow with reactive mitigation
  - Emergency alarms
- Controls
  - Automatic controls
  - Activated controls
- Connections
  - "Murphy" connections

NOTES

MITIGATION EQUIPMENT (cont.)

- Flares
- Scrubbers
- Water curtains
- Flame arrestors
- Explosion isolation devices

MITIGATION OPERATIONS

- Prevent releases if possible
- Mitigate releases that occur

MITIGATION OPERATIONS (cont.)

- Operational activities
  - Standard operating procedures (SOPs)
  - Standard maintenance procedures
  - Process inspections
  - Security
  - Emergency procedures

NOTES

AREAS FOR REVIEW
Design

- Is the process equipment suitable for its use?
- Is the process equipment compatible with other equipment, process chemicals, and process conditions?

AREAS FOR REVIEW
Design (cont.)

- Are replacement parts compatible with process equipment?
- Are warning signs and labels posted, easy to read, and accurate?

AREAS FOR REVIEW
Design (cont.)

- Are hazardous chemicals separated or isolated from incompatible chemicals?
- Are hazardous chemicals separated from sensitive populations?

NOTES

AREAS FOR REVIEW
Reduction

- Can raw material or product inventories be lowered?
- Can the number of hazardous material transfers be reduced? Is it wise to reduce them?

AREAS FOR REVIEW
Reduction (cont.)

- Would aggregate storage lead to smaller releases?
- Can less hazardous chemicals be substituted?
- Can hazardous chemical concentrations be reduced?

AREAS FOR REVIEW
Equipment

- What kinds of mitigative alarms and controls are in use? Are they effective and appropriate?
- What other kinds of mitigative equipment are in use? Is the equipment effective and appropriate?

NOTES

AREAS FOR REVIEW
Operations

- Is prevention and mitigation stressed in facility policies and procedures?
- Is prevention and mitigation consistent throughout the facility's documentation?

INFORMATION SOURCES

- Facility practices
  - Facility release history
  - Process inspections
  - Hazards analyses
  - Procedures manuals
  - Facility diagrams (P&IDs, etc.)

INFORMATION SOURCES (cont.)

- Mitigation recommendations
  - Past experience
  - Previous audits
  - Facility personnel

MAINTENANCE PROCEDURES AND TRAINING REQUIREMENTS

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- List four training requirements that are critical for a safe workplace
- Define three types of preventive maintenance
- List three critical elements of performance-based training
- Define job/task analysis
- Define needs analysis and its three essential components
- Describe each of the following types of emergency training:
    1. Evacuation training
    2. Emergency response training
    3. Hazardous materials (HAZMAT) training.

NOTES

MAINTENANCE PROCEDURES AND TRAINING REQUIREMENTS

MAINTENANCE PROCEDURES

- Repair procedures
- Preventive maintenance
- Lockout/tagout

MAINTENANCE PROCEDURES (cont.)

- Confined space entry
- Hot work permits
- Management of change

NOTES

REPAIR PROCEDURES

- Types of maintenance
  - Mechanical
  - Pipe fitting
  - Welding/boilermaking
  - Electrical
  - Instrumentation and control

REPAIR PROCEDURES (cont.)

- Sources of procedures
  - Written procedures
  - Technical manuals
  - Equipment manuals

PREVENTIVE MAINTENANCE

- Periodic maintenance
- Preventive maintenance
- Predictive maintenance

NOTES

LOCKOUT/TAGOUT

29 CFR 1910.147

- Isolation (control of energy)
  - Disconnect
  - Block
  - Blind
- Immobilization
- Group lockout/tagout

LOCKOUT/TAGOUT (cont.)

29 CFR 1910.147

- Training
- Written procedures
  - Standard procedures
  - Inspections
  - Documentation

CONFINED SPACE ENTRY

29 CFR 1910.146

- Written permit
- Hazards monitoring
- Protective equipment

NOTES

HOT WORK PERMITS

- Written permit
- Flammable atmospheres
- Protective equipment

MANAGEMENT OF CHANGE

29 CFR 119

- Technical basis for change
- Impact on safety and health
- Modifications to SOPs

MANAGEMENT OF CHANGE (cont.)

29 CFR 119

- Necessary time period for the change
- Authorization requirements

NOTES

TRAINING REQUIREMENTS

- Performance-based training
- Hazard communication training
- Emergency response training
- Contractor training

PERFORMANCE-BASED TRAINING

- Job/task analysis
- Training needs assessment
- Performance-based objectives

JOB/TASK ANALYSIS

- Job/task based
- Skills criteria
- Knowledge criteria

NOTES

TRAINING NEEDS ASSESSMENT

- Employee based
- Skills levels
- Knowledge levels

PERFORMANCE-BASED OBJECTIVES

- Compare criteria to levels
- Identify deficiencies
- Develop training objectives

HAZARD COMMUNICATION TRAINING

29 CFR 1910.1200

- Identify hazardous materials
- Acquire information
  - Marking and labeling
  - Material safety data sheets
- Establish training objectives

NOTES

EMERGENCY RESPONSE TRAINING

- Evacuation training - 29 CFR 1910.38(a)
- Emergency response training - 29 CFR 1910.120
  - Awareness level
  - Operations level

EMERGENCY RESPONSE TRAINING (cont.)

- *Hazardous materials* (HAZMAT) training
  - Technician
  - Specialist
  - Incident commander

AREAS FOR REVIEW

- Maintenance
- Training

NOTES

MAINTENANCE

- Accuracy
- Effectiveness
- Safety

MAINTENANCE
Accuracy

- Are procedures written for existing equipment?
- Are manufacturers' suggested procedures being used?

MAINTENANCE
Effectiveness

- Is type of maintenance supported by documentation?
- Have investigation recommendations been implemented?

NOTES

MAINTENANCE
Safety

- Are lockout, confined space, and hot work procedures in place, used, and documented?
- Is maintenance included in safety training?

TRAINING

- Planning
- Materials
- Application

TRAINING
Planning

- Does training meet job requirements and staff needs?
- Does training meet applicable safety requirements?

NOTES

TRAINING
Materials

- Are training materials up to date?
- Are training materials at proper educational level?

TRAINING
Application

- Is training documentation up to date?
- Have results of inspections been included in training?

CONDUCTING INTERVIEWS

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe the role of interviewing in chemical safety auditing.
- List two incentives and two disincentives for interviewee participation
- Describe interviewing techniques that establish style and climate

NOTES

CONDUCTING INTERVIEWS

INTERVIEWING

- One-way process
- Two-way process

INTERVIEWER/INTERVIEWEE RELATIONSHIP

- Trusted
- Feared
- Respected
- Beneficial

NOTES

CSA INTERVIEWS

- Incentives to participate
  - Personal safety
  - Self worth
  - Personal goals
- Disincentives to participate
  - Looking foolish
  - Retaliation

INTERVIEWS

- Style
  - Lawyer - Perry Mason
  - Sensationalizer - Geraldo Rivera
  - Accuser - Mike Wallace
  - Friend - Barbara Walters
- Climate
  - Intimidating (threatening)
  - Nonthreatening

RESPONSES TO QUESTIONS CONCERNING MISTAKES

- Minimize the problem
- Blame someone else
- Emphasize the improbability of the mistakes

NOTES

RESPONSES TO QUESTIONS CONCERNING MISTAKES (cont.)

- Be defensive
- Say the problem has already been corrected
- Protest being unfairly singled out

HOW DO YOU GET PEOPLE TO SHARE INFORMATION?

- Be empathetic
- Let them save face
- Be nonthreatening
- Praise them

HOW DO YOU GET PEOPLE TO SHARE INFORMATION? (cont.)

- Show appreciation when they share information
- Start with easy questions
- Make questions easy to answer

NOTES

PHRASING THE QUESTION

- In what ways do you think your present safety features are inadequate?
- What do you think are the best aspects of your current safety procedures? How do you think the procedures could be improved?

BEGINNING THE INTERVIEW

- Set the climate
- Explain the purpose
- Introduce everyone

RECORDING AN INTERVIEW

- Take notes
- Tape record the interview
- Assign a note taker
- Write or record from memory immediately after the interview

NOTES

DURING THE INTERVIEW
Types of Questions

- Open-ended
- Close-ended
- Probing
- Mirror
- Loaded or leading

AFTER THE INTERVIEW

- Thank the interviewee
- Review notes
- Ask follow-up questions

INCIDENT INVESTIGATION

PERFORMANCE OBJECTIVES

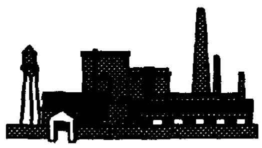
At the end of this lesson, participants will be able to:

- Define root cause, primary effect, cause-and-effect chain, culture, and climate

- Describe root cause analysis, cause tree analysis, barrier analysis, change analysis, and personnel performance analysis.

NOTES

INCIDENT INVESTIGATION



ROOT CAUSE Definition

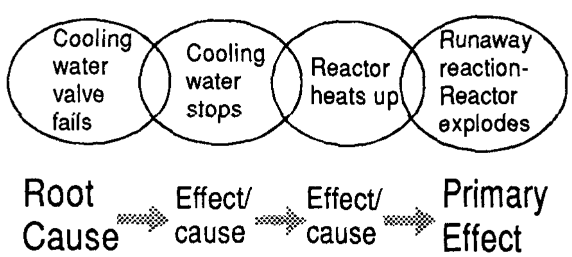
- Root cause

  The cause that, if removed, will prevent the primary effect

- Primary effect

  The effect or problem you are trying to prevent

CAUSE-AND-EFFECT CHAIN



NOTES

ROOT CAUSE CRITERIA

- Prevent recurrence
- Meet facility's goals
- Within facility's control

SOURCES OF CAUSE

- The source of all causes is design error
- The source of all causes is human error
- The source of all causes is nature

SOURCES OF CAUSE (cont.)

Assigning all causes to one source prevents workable solutions

NOTES

BASIC ELEMENTS OF ANALYSIS

- Define the problem
- Collect information
- Perform analysis
- Verify results

DEFINING THE PROBLEM

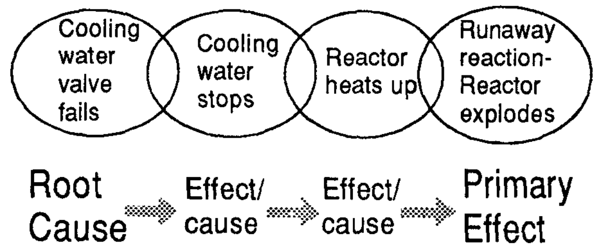
- What is the problem?
- When did it happen?
  - Relative to time
  - Relative to other parts of the problem

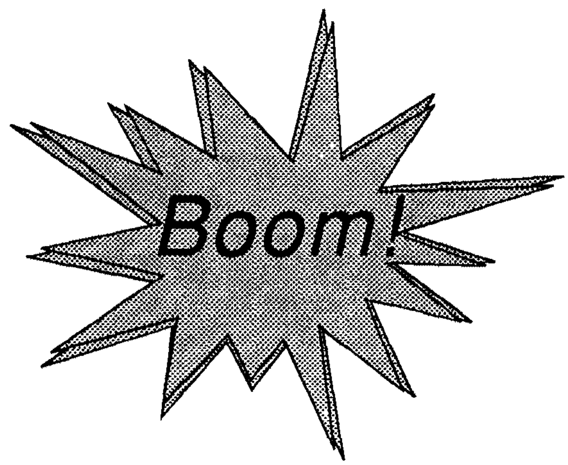
DEFINING THE PROBLEM (cont.)

- Where did it happen?
  - Physical location
  - Relative to associated components
- What is the significance?
  - Relative to the goals of the facility

NOTES

CAUSE-AND-EFFECT CHAIN





DEFINING THE PROBLEM

- What is the problem?
  A reactor overheated and exploded
- When did it happen?
  When the pneumatic cooling water valve failed and moved to the "closed" position

NOTES

DEFINING THE PROBLEM (cont.)

- When did it happen?
  The cooling water valve failed when the instrument air supply line to the valve broke
- Where did it happen?
  At the cooling water valve controller

DEFINING THE PROBLEM (cont.)

- What is the significance?
  The instrument air supply line for the cooling water valve broke

  The cooling water valve moved to the closed position

COLLECT INFORMATION Evidence Preservation Checklist

- Hardware
  - Equipment
  - Tools
  - Materials (removed and installed)

NOTES

COLLECT INFORMATION (cont.)

- Hardware
  - Location and placement of objects
  - Environmental factors (noise, heat, etc.)

Note: Hardware evidence should be preserved "as found" if possible

COLLECT INFORMATION (cont.)

Documentation

- Regulations and orders
- Procedures
- Work instructions
- Photographs

COLLECT INFORMATION (cont.)

Documentation

- Design drawings
- Operator logs
- Charts/computer records
- Maintenance records

NOTES

COLLECT INFORMATION (cont.)

- Personnel
  - Personnel statements
  - List of involved people
  - Work history
- Chronology of events

PERFORM ANALYSIS

- For best results, use two or more analytical techniques
- Use cause and effect as one technique
- Write the summary as cause and effect, starting with the primary effect

PERFORM ANALYSIS (cont.)

- Cause-and-effect analysis
- Cause tree analysis
- Barrier analysis
- Change analysis
- Personnel performance analysis

NOTES

CAUSE-AND-EFFECT ANALYSIS

The reactor overheated and exploded because cooling water flow stopped, which was caused by the cooling water valve closing, which was caused by 1) the instrument air supply line breaking and 2) the valve being installed in the fail closed position

CAUSE TREE ANALYSIS

Cooling Water Valve Failed Closed

Design	Valve designed to fail closed
Maintenance	Valve installed to fail closed
Inspection	No one noticed that the valve was fail closed

BARRIER ANALYSIS

No one noticed the fail closed valve

- Not in the inspection procedure
  - Problem: Improper procedure
- In procedure, but not checked
  - Problem: Lack of knowledge (training)
  - Problem: Lack of time (management policy)

NOTES

CHANGE ANALYSIS

The instrument air supply line broke

- We replaced the supply line 6 months ago
- We had to reroute it around the new "H" beam

CHANGE ANALYSIS (cont.)

- Investigation shows that vibration between the supply line and the "H" beam caused wear
- The line wore through and ruptured

PERSONNEL PERFORMANCE ANALYSIS

- Used exclusively for "people problems"
- Requires a solid understanding of human nature
- Helpful in identifying culture and climate

NOTES

CULTURE AND CLIMATE

- Culture is the sum of organizational attitudes as expressed by behavior, decisions, and beliefs
- Climate is the working environment that results from management policies and actions

CULTURE AND CLIMATE (cont.)

- A direct result of management style
- Often a major source of root causes
- Established within the first 1 or 2 years

PROBLEM CLIMATES

- Broke/fix
  "If it ain't broke, don't fix it"
- Regulatory fixation
  "I don't care if it's wrong, the regulator said to do it"
- Not made here
  "What do they know? We've got our own experts"

NOTES

PROBLEM CLIMATES (cont.)

- Management by fear
  "Just do what you're told"
- Blame someone
  "He really fouled up"
- Shoot the messenger
  "I'm not going to tell them it didn't work"

CULTURAL CHANGES

Major reorganization of top level management is usually the only way cultural changes occur

VERIFY ROOT CAUSE

- Verify that the corrective action will actually prevent recurrence
- Verify that the corrective action is commensurate with the stated root cause

NOTES

FALSE ROOT CAUSES

"The root cause was human error"

Human error is a category, not a cause (it is too broad)

FALSE ROOT CAUSES (cont.)

"The root cause was bearing failure"

This statement stopped too soon. Why did the bearing fail?

ROOT CAUSE CATEGORIES

Personnel performance problems

- Rules known but not used
- Lack of attention
- Inadequate communication
- Inadequate training

NOTES

ROOT CAUSE CATEGORIES (cont.)

Rule problems

- Not defined
- Incomplete
- Incorrect
- Not enforced

ROOT CAUSE CATEGORIES (cont.)

Hardware problems

- Design deficiency
- Manufacturing deficiency
- Installation deficiency

Note: Wearout and/or maintenance are NOT root causes

MAXIMS OF ROOT CAUSE

- If you do not find and correct the root cause, you are doomed to repeat it
- If you repeat a problem, by definition you have a programmatic deficiency

NOTES

MAXIMS OF ROOT CAUSE (cont.)

- Satisfying the need to be needed will prevent more personnel problems than any other act
- The essence of root cause analysis is to think cause and effect

HAZARD EVALUATION

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Define the following hazard evaluation/analysis terms:
  - Hazards
  - Accidents
  - Consequences
  - Probability
  - Frequency
  - Likelihood
  - Risk

- Describe the uses, advantages, and disadvantages of process safety checklists

- Describe the uses, advantages, and disadvantages of safety reviews/audits

- Describe the uses, advantages, and disadvantages of preliminary hazard analyses.

NOTES

HAZARD EVALUATION

HAZARD EVALUATION

- Identifies and describes hazards and hazard scenarios
- Estimates the likelihood and consequences of hazard scenarios
- Establishes relative risks of hazards
- Suggests approaches to risk reduction

HAZARD EVALUATION (cont.)

- Definitions
- Techniques
  - Checklist
  - Safety review
  - Preliminary hazards analysis

NOTES

DEFINITIONS

- Hazards
  - Unsafe acts or conditions that create the potential for an accident with undesirable consequences

DEFINITIONS (cont.)

- Hazards
  - Loss of containment of flammable, combustible, highly reactive, or toxic materials
  - Uncontrolled electrical hazards or mechanical overpressure

DEFINITIONS (cont.)

- Accident
  - Unplanned sequence of events that has an undesirable consequence
- Consequence
  - The impact of the accident in terms of the effects on people, property, or environment

NOTES

DEFINITIONS (cont.)

- Probability
  - The statistical chance of an event occurring in a given period of time
- Frequency
  - The number of occurrences per unit of time

DEFINITIONS (cont.)

- Likelihood
  - Probability or frequency
- Risk
  - A measure of potential human injury, economic loss, or environmental impact in terms of its likelihood and consequences

CHECKLIST

- Simple to implement
- Covers questions about design and operation
- Designs questions with "yes" or "no" answers
- Identifies common hazards to ensure compliance

NOTES

CHECKLIST (cont.)

- Applies to equipment, materials, or procedures associated with facility changes
- Does not help identify new or unrecognized hazards
- Prepared by experienced engineer

CHECKLIST (cont.)

- Requires knowledge of system/facility and SOPs
- Used during any stage of a project
- Should be audited and updated regularly

CHECKLIST Advantages

- Easy to use
- Gives quick results
- Level of detail can be varied
- Communicates information well

NOTES

CHECKLIST
Disadvantages

- Limited to author's experience
- Repetition can lead to errors
- Provides minimum level of hazard evaluation

SAFETY REVIEW

- Formal onsite examination of facility
- Simple to implement
- Identifies facility conditions or operating procedures that could lead to an accident

SAFETY REVIEW (cont.)

- Reviews major risk situations, not general housekeeping
- Output consists of recommendations and justifications for needed actions

NOTES

SAFETY REVIEW (cont.)

- Includes interviews with operators, maintenance staff, engineers, and management
- Can use other techniques, such as checklists and fault trees

SAFETY REVIEW (cont.)

- Input should include applicable codes and standards; PFDs; P&IDs; procedures; maintenance, inspection, and testing records; and process material characteristics
- May take several people 1 week or more

SAFETY REVIEW Advantages

- Studies actual equipment and operating procedures
- Sensitizes facility staff to hazard awareness

NOTES

SAFETY REVIEW Disadvantages

- Method lacks formal structure
- Reviewers need to be experienced

PRELIMINARY HAZARDS ANALYSIS (PHA)

- Formal in its implementation
- Originally developed to identify hazards during early design
- Focuses on hazardous materials and major plant systems

PHA (cont.)

- Developed by creating a list of hazards related to materials, equipment, and operating environment
- Identify the hazard
  - List the potential cause and effect
  - List possible corrective or preventive measures

NOTES

PHA (cont.)

- Requires input data such as unit design criteria and standards, and equipment and material specifications
- Prioritizes system for more detailed analysis

PHA (cont.)

- Advantages
  - Safety engineers can perform task quicker
  - Provides early identification of hazards
- Disadvantage
  - Will not provide a detailed hazard analysis

HAZARD EVALUATION TECHNIQUES

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe "What If" analysis
- Describe HAZOP studies
- Describe FMECA
- Describe fault tree analysis
- Describe event tree analysis.

NOTES

HAZARD EVALUATION TECHNIQUES

HAZARD EVALUATION

- "What If" analysis
- HAZOP studies
- FMECA
- Fault tree analysis
- Event tree analysis

"WHAT IF" ANALYSIS

- Examines possible deviations from:
  - Design
  - Construction
  - Modification
  - Operating intent

NOTES

"WHAT IF" ANALYSIS (cont.)

- Questions
  - What if Pump A stops running?
  - What if the operator opens Valve B instead of Valve A?

"WHAT IF" ANALYSIS (cont.)

- Used to identify
  - Hazards
  - Hazards scenarios
  - Consequences
  - Methods of risk reduction
- Loose structure - concept adapted to specific application

"WHAT IF" ANALYSIS (cont.)

- Questions from previous analyses are used as a guide
- Questions are almost invariably added as analysis proceeds
- Commonly used to examine proposed changes to an existing facility/unit

NOTES

"WHAT IF" ANALYSIS (cont.)

- Analyzes materials, products, operating procedures, and management practices
- Questions usually start with the inputs to the process and follow their flow

"WHAT IF" ANALYSIS (cont.)

- Input information
  - Facility/unit documentation
  - Process documentation
  - Operating procedures
  - Operations interviews
  - Maintenance interviews
- Users should be experienced

"WHAT IF" ANALYSIS (cont.)

- Advantages
  - Easy to use
  - Flexible
- Disadvantages
  - Loose structure
  - Results depend on users' experience

NOTES

HAZARDS AND OPERABILITY (HAZOP) STUDIES

- More structured than "What If" analysis
- Description
  - Multidisciplinary team
  - Deviations from design intent
  - Brainstorming

HAZOP STUDIES (cont.)

- Description
  - Systematically guided through facility/unit design
  - Structure provided by "guide words"

HAZOP STUDIES (cont.)

Results include

- Identification of hazards
- Operability problems
- Recommended changes to improve safety

NOTES

HAZOP STUDIES (cont.)

- Deviations are shown by applying guide words to process parameters at nodes (processing points)
- For each deviation, the team identifies credible causes and significant consequences

HAZOP STUDIES (cont.)

Guide words

- No
- More
- Less
- As well as
- Part of
- Reverse
- Than

HAZOP STUDIES (cont.)

Parameters

- Flow
- Pressure
- Temperature
- Level

NOTES

HAZOP STUDIES (cont.)

Nodes
- Main feed pumps
- Reactor
- Reactor Feed A
- Reactor cooling water

HAZOP STUDIES (cont.)

- HAZOP studies are performed in team meetings
- Nodes are specified by the team leader before the meeting (*example*: cooling water flow)

HAZOP STUDIES (cont.)

- Guide words applied
  - No cooling water flow
  - More cooling water flow
  - Less cooling water flow
  - Part of cooling water flow
- The focus is problem identification, not necessarily problem solution

NOTES

HAZOP STUDIES (cont.)

- Advantages
  - Provides greatest assurance that all hazards have been identified
  - Can provide both hazard and operability information

HAZOP STUDIES (cont.)

- Disadvantages
  - Effort involved can be significant
  - Effort is proportional to complexity of facility/unit and depth of detail

FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS

- FMECA
- Tabulates
  - Facility/unit equipment
  - Equipment failure modes
  - Result of failure
  - Modes that contribute to accidents
  - Criticality ranking of accident (likelihood + severity)

NOTES

FMECA (cont.)

- Advantage
  - Systematic, element by element procedure that helps ensure completeness

FMECA (cont.)

- Disadvantages
  - Not efficient at identifying combinations of equipment failures
  - Human errors are not usually examined

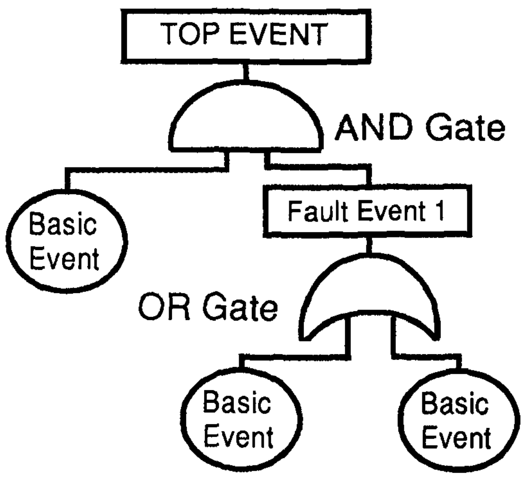
FAULT TREE ANALYSIS

- Formal, deductive technique that focuses on one particular incident (top event)
- Graphically displays combinations of equipment failures and human errors that result in an accident

NOTES

FAULT TREE ANALYSIS (cont.)

- Can be used to determine the basic cause(s) of an incident
- Can be used to estimate the likelihood of an incident
- Requires a complete understanding of system function, failure modes, and their effects



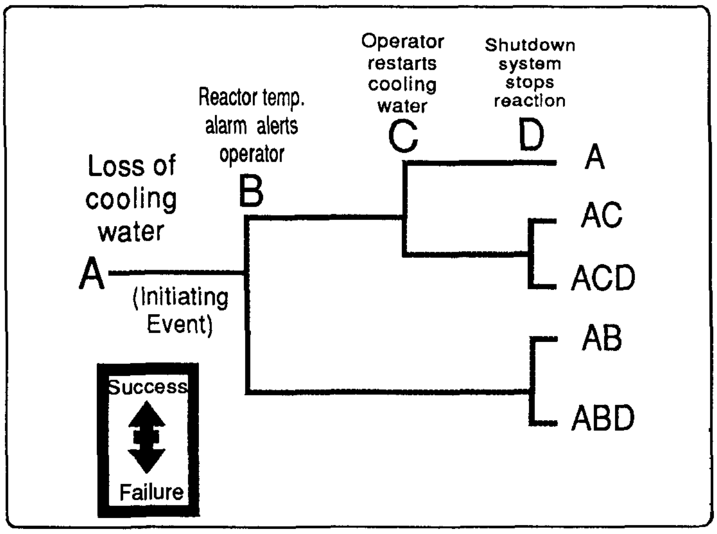
FAULT TREE ANALYSIS (cont.)

- Advantages
  - Thorough
  - Systematic
- Disadvantages
  - Binary (not efficient at identifying failures with more than two inputs)
  - Can be time consuming

NOTES

EVENT TREE ANALYSIS

- Formal, inductive technique that focuses on a sequence of events that leads to an incident
- Considers the response of operators, safety systems, etc., to an initiating event
- Produces chronological sets of failures that define an incident



EVENT TREE ANALYSIS (cont.)

- Advantages
  - Graphical, systematic representation
  - Easy to perform
  - Easy to understand
- Disadvantage
  - Binary representation of failures

EMERGENCY RESPONSE

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- List four key elements of an emergency action plan

- Describe three types of emergency evacuation plans

- Describe each of the following key elements comprising an emergency response plan:

    1. Safe distances
    2. Site security and control
    3. Evacuation routes and procedures
    4. Emergency medical treatment
    5. Alerting and response procedures
    6. Critique and follow-up
    7. PPE and emergency equipment
    8. Medical surveillance
    9. Training

- List three events that initiate reporting requirements for emergency response actions

- Define *reportable quantity*.

NOTES

EMERGENCY RESPONSE

EMERGENCY RESPONSE

- Emergency action plans
  29 CFR 1910.38(a)
- Emergency response plans
  29 CFR 1910.120/SARA Title III
- Release notification
- Areas for auditor review

EMERGENCY ACTION PLANS

- For evacuation only
  (outside agencies handle the response)
- Written plan
  (if more than 10 employees)
- Covers all reasonably expected emergencies

NOTES

ACTION PLAN ELEMENTS

- Account for all employees
- Assign rescue and medical duties
- List personnel to be contacted for further information
- Include types of evacuations

TYPES OF EVACUATION PLANS

- Full and immediate evacuation
- Nonessential personnel evacuation
- Partial evacuation (e.g., locally contained fires)

SAFE REFUGES

- Inside the facility (protected interior or exterior areas)
- Offsite evacuations

NOTES

ALARMS

29 CFR 1910.165

- Perceivable
  (audible and/or visible)
- Distinctive
- Established activating procedure
- Operational at all times

TRAINING FOR EVACUATION

- Train designated personnel to assist in evacuation
- Review the evacuation plan
  - When the plan is developed
  - Whenever the employee's actions change
  - Whenever the plan changes

REQUIREMENTS FOR EMERGENCY ACTION PLANS

- Shall be kept in the workplace
- Shall be available for employee review
- Shall include handling small releases (handled by employees in the immediate area of the release - is NOT an emergency response)

NOTES

EMERGENCY RESPONSE PLANS

- Safe distances
- Site security and control
- Evacuation routes and procedures
- Decontamination procedures

EMERGENCY RESPONSE PLANS (cont.)

- Emergency medical treatment
- Alerting and response procedures
- Critiques and follow-up
  - Proactive critiques
  - Plan reviews
  - Actual responses

EMERGENCY RESPONSE PLANS (cont.)

- Personal protective equipment (PPE) and emergency equipment
- Medical surveillance
- Training

NOTES

TRAINING

- Responder awareness level
  - Emergency recognition
  - Alarm activation
  - PPE and emergency equipment

TRAINING (cont.)

- Responder operations level
  - Hazards and risk assessment
  - Control and containment
  - Decontamination
  - SOPs and termination procedures

HAZMAT TRAINING

Emergency response personnel

- Technician
- Specialist
- Incident commander

NOTES

REPORTING REQUIREMENTS

- Hazardous substances
- Extremely hazardous substances
- Exposures beyond facility boundaries

HAZARDOUS SUBSTANCES

- Reportable quantities
  40 CFR Table 302.4
- Reported to the National Response Center

EXTREMELY HAZARDOUS SUBSTANCES

- Reportable quantities
  40 CFR 355 Appendices A and B
- Reported to:
  - National Response Center
  - LEPC Emergency Coordinator
  - SERC

NOTES

EXPOSURES BEYOND FACILITY BOUNDARIES

- Chemical name
- Time and duration of release
- Release medium/media

EXPOSURES BEYOND FACILITY BOUNDARIES (cont.)

- Health risks and precautions
- Name and telephone number for additional information

AREAS FOR REVIEW

- Is plan complete and appropriate?
- Is plan coordinated with local, state, and regional plans?

NOTES

AREAS FOR REVIEW (cont.)

- Has training been completed and documented?
- Have critiques been done?
  - Tabletop exercises
  - Simulations

PROCESS INSPECTION TECHNIQUES

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- List five essential steps in preparing for an inspection
- List seven background documents that may be reviewed in preparation for an inspection
- List five criteria commonly used to inspect valves and piping
- List six areas of evaluation during inspection of process controls
- List five operating practices that should be examined during operations inspections
- List seven items that should be examined during evaluation of a plant's emergency response plan
- List eight maintenance or repair practices to be evaluated during maintenance inspections
- Describe how to follow a logical order of progression while performing inspections.

NOTES

PROCESS INSPECTION TECHNIQUES

INSPECTION TECHNIQUES

- Preparing for inspections
- Process equipment inspections
- Operations inspections
- Maintenance inspections
- Helpful hints

PREPARING FOR INSPECTIONS

- Review background documents
  - SOPs, emergency procedures
  - Block diagrams, P&IDs
  - Training manuals
  - Management policies

NOTES

PREPARING FOR INSPECTIONS (cont.)

- Review background documents
  - *Release reports*
  - Incident investigation reports
  - Process hazards analyses

PREPARING FOR INSPECTIONS (cont.)

- Review technical literature
- Review process hazards
- Determine scope of audit
- Prepare health and safety plan

PROCESS EQUIPMENT INSPECTIONS

- Overall impression
  - Condition
  - Housekeeping
  - Accessibility of safety/ emergency equipment

NOTES

PROCESS EQUIPMENT INSPECTIONS (cont.)

- Process equipment layout
  - Separation of flammables/ incompatible chemicals
  - Access for emergency respirators

PROCESS EQUIPMENT INSPECTIONS (cont.)

- Tanks and vessels
  - Condition and spacing
  - Containment
  - Marking/labeling
  - Grounding
  - Alarms and controls

PROCESS EQUIPMENT INSPECTIONS (cont.)

- Valves and piping
  - Condition
  - Suitability
  - Labeling/color coding
  - Accessibility
  - Conformance with P&IDs

NOTES

PROCESS EQUIPMENT INSPECTIONS (cont.)

- Safety/emergency equipment
  - Condition
  - Suitability
  - Accessibility
  - Compatibility

PROCESS EQUIPMENT INSPECTIONS (cont.)

- Process controls
  - Condition
  - Control logic
  - Suitability
  - Visibility
  - Manual operation
  - Conformance with P&IDs

OPERATIONS INSPECTIONS

- Operating practices
  - Conformance with policies and procedures
  - Overtime requirements
  - Supervision
  - Training
  - Communication with maintenance and contractors

NOTES

OPERATIONS INSPECTIONS (cont.)

- Supervision and management
  - Management philosophy
  - Management training
  - Supervisor availability
  - Incident documentation
  - Process hazards analyses
  - Process audit procedures

OPERATIONS INSPECTIONS (cont.)

- Safety and accident prevention
  - Incident investigation reports
  - Documentation of safety meetings
  - Management attitudes
  - Employee attitudes

OPERATIONS INSPECTIONS (cont.)

- Training
  - Conformance with requirements
  - Task analyses
  - Needs analyses
  - Job-/task-based objectives
  - Schedules and documentation
  - Contractor training

NOTES

OPERATIONS INSPECTIONS (cont.)

- Emergency response
  - Response plan suitability
  - Response plan availability
  - HAZMAT training
  - Response initiation policies
  - *Emergency notification policies*
  - Coordination with local authorities
  - Exercises and simulations

MAINTENANCE INSPECTIONS

- Repair practices
  - Repair procedures
  - Lockout/tagout procedures
  - Hot work procedures
  - Confined space procedures
  - Suitability of spare parts
  - Compatibility of spare parts
  - Coordination with operations
  - Coordination with contractors

MAINTENANCE INSPECTIONS (cont.)

- Preventive maintenance
  - Periodic, preventive, or predictive maintenance
  - Documentation
  - Inspection policies

NOTES

HELPFUL HINTS

- Determine the scope of the inspection before the site visit
- Use a logical order for the inspection
  - For equipment, follow the flow path
  - For operations, start with general concerns and work toward specific concerns

HELPFUL HINTS (cont.)

- Make checklists and take notes
- First impressions are often accurate

AUDIT REPORT WRITING

PERFORMANCE OBJECTIVES

At the end of this lesson, participants will be able to:

- Describe the writing style and consistency requirements for the 13 major report sections shown in the EPA chemical safety audit program protocol

- Describe the report disclaimer and requirements for limiting access to draft reports, for handling confidential information, and for finalizing and distributing the report.

NOTES

AUDIT REPORT WRITING

AUDIT REPORT WRITING

- Preparing to write
- Writing the report
- Distributing the report

PREPARING TO WRITE

- Postvisit meeting
- Follow-up information
- Standard report disclaimer

NOTES

POSTVISIT MEETING

Reassemble the team as soon as possible
- Details can fade from memory
- Details can become confused

FOLLOW-UP INFORMATION

- Team leader designates someone to ask follow-up questions as needed
- Follow-up
  - Letter
  - Telephone call
  - In person

STANDARD REPORT DISCLAIMER

- Describes the scope and limitations of the audit
- Required part of the audit report
- Found in Section 6.2, page 46, of the guidance manual

NOTES

WRITING THE REPORT

- Writing style
- Flexibility
- Report sections

WRITING STYLE

- Factual
- Relevant
- Complete
- Objective

WRITING STYLE (cont.)

- Clear
- Consistent
  - Statements in the report ARE NOT contradictory
  - The report appears to be written by one person

NOTES

FLEXIBILITY

- All 13 sections of the audit report MUST be addressed
- If a section is not relevant or was not audited, state this in the report
- Subsections DO NOT have to be addressed separately

REPORT SECTIONS

- Introductory and background information
  - Sections 1 - 4
- Chemical hazards and process information
  - Sections 5 - 6

REPORT SECTIONS (cont.)

- Accident prevention and emergency preparedness
  - Sections 7 - 11
- Conclusions and recommendations
  - Sections 12 - 13
- Appendices

NOTES

INTRODUCTORY AND BACKGROUND INFORMATION

- Section 1 - Introduction
- Section 2 - Summary of findings and *conclusions*
- Section 3 - Background
- Section 4 - Facility background information

CHEMICAL HAZARDS AND PROCESS INFORMATION

- Section 5 - Chemical hazards
- Section 6 - Process information for hazardous chemicals

ACCIDENT PREVENTION AND EMERGENCY PREPAREDNESS

- Section 7 - Chemical accident prevention
- Section 8 - Accidental release incident investigation

NOTES

ACCIDENT PREVENTION AND EMERGENCY PREPAREDNESS

- Section 9 - Facility emergency preparedness activities
- Section 10 - Community and facility emergency response planning activities

ACCIDENT PREVENTION AND EMERGENCY PREPAREDNESS

- Section 11 - Public alert and notification procedures

CONCLUSIONS

- Section 12 - Conclusions
  - Based on facts
  - Positive and negative
  - Highlight safety practices

NOTES

RECOMMENDATIONS

- Section 13 - Recommendations
  - Observed and documented facility practices
  - Factual, clear, and nonjudgmental
  - Technically feasible

APPENDICES

- Useful and relevant to the report
- Referenced in the body of the report
- Examples - list of audit team members, MSDS, maps and charts, accidental release report(s), and unique SOPs

DISTRIBUTING THE REPORT

- Information access
- Report recipients

NOTES

INFORMATION ACCESS

- Mark preapproval (draft) report as follows:
  1. "Pre-decisional Document, Not Disclosable Under FOIA"
  2. "Do Not Cite or Quote"

INFORMATION ACCESS (cont.)

- Confidential information
  - Available to EPA, TATs, and AARP
  - Not available to state or local team members

REPORT DISTRIBUTION

- Handled by Regional CEPPO
- Distributed to:
  - SERCs and LEPCs
  - Facility owner and operator
  - EPA headquarters
  - Any assisting agencies

Guidance Manual for

EPA Chemical Safety Audit Team Members

Chemical Emergency Preparedness and Prevention Office

Office of Solid Waste and Emergency Response

U.S. Environmental Protection Agency

June 1993

Note: This Manual supersedes all previous versions.

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Attachments

1. Chemical Safety Audit Program Fact Sheet
2. CERCLA Provisions Overview and CERCLA Statute
3. Model Site Safety Plan for Chemical Safety Audits
4. Sources of Information Concerning Hazardous Substance Releases
5. Sample First Letter to Facility Owner/Operator
6. Sample Letter to Facility Owner/Operator Who has not Responded or Consented to the Audit
7. Standard Report Disclaimer
8. Standard Language for Audit Report Introduction
9. Documentation Pertaining to the Processes and Operations Using Hazardous Substances
10. Description of Standard Operating Procedure Manuals
11. Blank CSA Report Profile
12. Annotated CSA Report Profile

1. Introduction

1.1 Purpose of this Manual

The purpose of this Manual is to provide guidance to the U.S. EPA regional offices in implementing the Chemical Safety Audit (CSA) program, which is an outgrowth of the efforts of the Environmental Protection Agency (EPA) under the Chemical Accident Prevention (CAP) program. This document is intended solely as guidance. It does not represent final agency action nor is it ripe for judicial review. This is not intended, nor can it be relied upon, to create any rights enforceable by any party in litigation with the United States. The Agency may change this guidance at any time without public notice.

This Manual, commonly referred to as the "Blue Book," includes a discussion of the following topics:

- Audit authority under CERCLA;
- Roles and responsibilities of audit team members;
- Audit preparation;
- Conducting the audit;
- Audit protocol and report preparation; and
- Audit follow-up activities.

It is recommended that each audit team member have a copy of this Manual to be used in conjunction with the Training Manuals provided at the Chemical Safety Audit Training Course. This Manual contains recommended actions, as well as mandatory procedures that must be followed to ensure the health and safety of program auditors as well as program integrity. All required/mandatory procedures or activities presented in this Manual are identified with the words "**[Required Activity]**" at the end of the sentence in which they are presented. Unless noted as a required activity, the described procedure is considered a recommendation, and the regional office has discretion in its implementation.

1.2 Program Background and Overview

The Chemical Accident Prevention (CAP) program emerged from concerns raised by the release of methyl isocyanate at Bhopal, India, and of aldicarb oxime at Institute, West Virginia. Awareness of the critical threat to public safety posed by similar incidents led to an emphasis on preparedness and planning for response to chemical accidents. Simultaneous with the development of preparedness activities by EPA was the passage and implementation of the Emergency Planning and Community Right-to-Know Act -- Title III of the Superfund Amendments and Reauthorization Act (SARA) in 1986. Because prevention is the most effective form of preparedness, the CAP program promotes the effort to enhance chemical accident prevention activities. The primary objectives of the CAP program are to identify the causes of accidental releases of hazardous substances and the means to prevent them from occurring, to promote industry initiatives in these areas, and to coordinate activities with the community, industry, and other groups (e.g., academia, professional organizations, and trade associations).

Many of the key concerns of the CAP program arise from the SARA Title III section 305(b) study entitled Review of Emergency Systems. This study, published in June 1988, made a number of recommendations on the future course of prevention activities by EPA, and identified several aspects of current practices that will require careful consideration in an overall prevention strategy. The study identified the importance of facility management commitment to implementing and maintaining systems to prevent, mitigate, and prepare for potential chemical accidents. First, while it is evident that risk awareness among the larger chemical producers is high, many large distributors and users of hazardous chemicals, as well as many smaller operations, have not yet attained a comparable level of accident consciousness. The study also indicated the need for new technologies in certain key areas: process area monitoring devices, back-up detectors, mitigation devices, and practices to adequately identify disabled equipment of these types. Third, the report suggested that a great degree of caution must be exercised in analyses using real-time dispersion models, and indicated that employee familiarity with hazard evaluation methods was limited, which in turn suggests that improper or ineffective techniques may be in practice. Finally, the examination of management practices revealed a failure to place sufficient emphasis on safety-related issues such as standard operating procedures, employee training, preventive maintenance, and post-accident investigation, as well as a general lack of commitment to safety.

As a follow-up to this national prevention study, EPA has undertaken cooperative initiatives with other federal agencies, states, industry, professional organizations, and trade associations, as well as environmental groups and academia. These joint efforts have and will continue to serve to determine and implement a mechanism for developing and sharing information on release prevention technology and practices, and to enhance the state of practice in the chemical process safety arena. In addition, EPA analyzes and disseminates information on accident prevention practices and technologies garnered from the Accidental Release Information Program, Acute Hazardous Events, Emergency Release Notification System, and National Response Center databases; on-scene coordinator reports; and EPA audits and inspections. Finally, with the inclusion of the facility risk management provisions in the Clean Air Act Amendments of 1990, the accident prevention goals of the CSA program have been formalized.

The Chemical Safety Audit program is part of the CAP initiative and has been designed to accomplish the following chemical accident prevention goals:

- Visit facilities handling hazardous substances to gather information on safety practices and technologies;

- Heighten awareness of the need for, and promote, chemical safety among facilities handling hazardous substances, as well as in communities where chemicals are located;

- Build cooperation among facilities, EPA, and other authorized parties by coordinating joint audits; and

- Establish a database for the assembly and distribution of chemical process safety management information obtained from the facility audits.

The chemical safety audit itself consists of interviews with facility personnel and on-site review of various aspects of facility operations related to the prevention of accidental chemical releases. Specific topics addressed include:

- Awareness of chemical and process hazards;

- Process characteristics;

- Emergency planning and preparedness activities;

- Hazard evaluation and release modelling efforts;

- Release detection and monitoring techniques;

- Training of operators and emergency response personnel;

- Facility and corporate management structure;

- Preventive maintenance and inspection programs; and

- Community notification mechanisms and techniques.

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 to its corporate management so that weak and strong program areas may be recognized. The audit reports are intended to contribute to the study of emergency systems begun in the Review of Emergency Systems, and in turn, to produce improvements in the ability of the audited facilities -- and industry in general -- to prevent or mitigate releases of hazardous substances and to share this information with the community and other interested groups. In this fashion, the CSA program serves as a vital component of EPA's Chemical Accident Prevention Program. **Attachment 1** contains the Chemical Safety Audit Program Fact Sheet, which summarizes the audit program background, goals, and scope. It can be used as a separate document to inform interested parties about the audit program.

It should be noted that the CSA program is not a compliance or inspection program. 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. However, if serious problems are discovered during the audit, EPA has a variety of legal authorities to use in response to them, which are discussed later in the body of this Manual. Violations observed during the course of an audit may also be referred to the respective EPA program office or federal agency or department for determination of what actions are to be taken following the audit.

1.3 CSA Program and Section 112(r) of the Clean Air Act

The future direction of both the CAP program and the CSA program will be very much affected by the passage of the Clean Air Act (CAA) Amendments of 1990. The accidental release prevention requirements found in section 112(r) of the Clean Air Act require EPA to promulgate regulations that require certain facilities to take steps to prevent accidental releases of chemicals and mitigate the severity of releases that do occur.

The facilities that will be covered by these regulations will be defined by a list of substances and threshold quantities that EPA will promulgate. The Accidental Release Prevention (ARP) regulations will require that facilities develop and implement a risk management plan (RMP) -- including a hazard assessment (off-site consequence analysis and a five-year accident history), a prevention program, and an emergency response program -- within three years after promulgation of the regulation. The RMP will be registered with EPA, and submitted to the Chemical Safety and Hazard Investigation Board, the state, and local emergency planning and response authorities. The RMP will also be made available to the public.

The CAA also requires EPA to establish an auditing system to review, and if necessary require revision of the RMPs submitted by facilities. The auditing system in the RMP rule outlines criteria for selecting facilities for audits. A more detailed auditing strategy is being proposed in the guidance to states for implementation of the ARP program. CAA section 507 further requires states to provide small businesses with technical assistance on how to comply with the Act.

The role of the CSA program in advancing EPA's accident prevention initiative, particularly its relevance in the context of the new section 112(r) requirements, will continue to evolve. In the short term, the regions should continue to perform audits under the current CSA format until they and the states begin administering the ARP program under section 112(r). The goal is to ensure that the states' auditing and inspection programs and technical assistance capability are adequate to assume the primary responsibilities of the ARP program.

2. Program Authority under CERCLA

2.1 Purpose of the Statute

The Comprehensive, Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) was enacted December 11, 1980, and amended by the Superfund Amendments and Reauthorization Act (SARA) on October 17, 1986. CERCLA authorizes the federal government to respond where there is a release or a substantial threat of a release into the environment of any hazardous substance, pollutant, or contaminant that may present danger to the public health or welfare or to the environment. **Attachment 2** contains an overview of major CERCLA provisions related to the CSA program. These include CERCLA sections 104(a), 104(b), 104(e), and 106(a). The statutory text is also included, 42 U.S.C.A. sections 9601, 9604, and 9606.

2.2 Facility Entry and Information Gathering Tools

2.2.1 Statutory Authority

CERCLA sections 104(b) and 104(e), as amended by SARA in 1986, provide authorities for entering a facility and accessing information. While CERCLA provides authority for states to use statutory authorities for entry and information gathering, such authorities may only be accessed pursuant to a contract or cooperative agreement with the federal government. Since no state currently has such an arrangement, states, as well as local governments, must use their own authorities for audit participation. **[Required Activity]**

2.2.2 EPA Policy and Practice

When entering pursuant to CERCLA, EPA auditors must ensure that the facility has experienced a release of a hazardous substance, pollutant, or contaminant, or that there is "reason to believe" that there exists a threat of such a release. The audits are intended to be non-confrontational and positive, cooperative efforts, such that information on safety practices, techniques, and technologies can be identified and shared between EPA and the facility. Consequently, and in conformance with other EPA program policies, audits will be performed under the above authority pursuant to the consent of the facility owner or operator. Consensual entry, however, can be revoked at any time during the audit. When withdrawal of consent takes place, the audit team shall leave the facility, regardless of the fact that the team has the authority to be there. **[Required Activity]** In either situation (i.e., entry refusal prior to audit or during audit), if consent is lacking, an order can be issued to require entry. Section 4.2 of this Manual provides guidance on obtaining entry upon consent and actions to be taken if the facility refuses entry.

An audit can also be conducted at facility invitation. When entering at the invitation of the facility (i.e., not pursuant to CERCLA authority or other statutory authorities), the audit scope can potentially be limited, since the facility determines what information will be made available to the audit team. In addition, invitational entry can be revoked by the facility at any time during the audit. The audit team has no legal authority (i.e., as compared to consensual entry) to continue the audit, and must leave the facility. **[Required Activity]**

The only exception to the described facility discretion concerning entry withdrawal for both consensual and invitational entry is if the audit team identifies a release or threat of a release of a CERCLA hazardous substance from a facility into the environment. If either of these situations are observed, the audit team must follow the prescribed procedures in section 2.3 of this Manual. **[Required Activity]**

2.2.3 Confidential Information

During the course of an audit, team members may encounter information that may be entitled to confidential treatment. Facilities can claim confidentiality on information under CERCLA section 104(e), as amended. If confidential business information (CBI) at a facility has been collected under another authority (e.g., TSCA, CWA), CERCLA section 104(e) allows authorized team members to handle this confidential business information as CERCLA CBI.

This information will be handled in accordance with 40 CFR Part 2. Authorized representatives and Agency employees can access and view CBI under CERCLA. Contractors who are pre-identified by contractor name and contract number to the facility can have access to this data (refer to section 4.2 of this Manual). On February 5, 1993, EPA's Office of General Counsel issued a rule (58 FR 7187) that authorizes the disclosure of CBI information (collected under a variety of environmental statutes, including CERCLA section 104) to enrollees in the Senior Environmental Employment (SEE) Program. Thus, members of the American Association of Retired Persons (AARP) now have the same access to CBI as EPA employees.

There are no specific training courses for handling CERCLA CBI, either on-site or off-site. In general, all confidential information must be marked as such and placed in a locked filing cabinet or a safe. It is advisable, however, that audit participants take a regional CBI course.

2.2.4 Attorney-Client Privilege

In the event that a facility withholds information based upon "attorney-client privilege," the regional Office of Regional Counsel (ORC) should be immediately notified and provided the following information:

- Name of document(s) withheld;

- Specific reason why withheld; and

- Name of facility attorney, address, and telephone number.

If a request for information during the course of the audit is refused, the audit should continue unless the absence of the requested document(s) makes it impossible to do so. The Office of Regional Counsel should be consulted of the refusal after the site visit and requested to pursue the matter as necessary.

2.3 Response Actions if a Release or a Threat of a Release Exists

During an audit, the team may observe a release or the potential for a release of a CERCLA hazardous substance from a facility into the environment.

If a release is observed, the team members must take the following actions: **[Required Activity]**

- Follow facility emergency evacuation procedures to safety; and

- Regroup; the Team Leader must notify the Regional Emergency Response Section to inform the on-duty On-Scene Coordinator (OSC) of events occurring at the facility. This action is not intended to serve as the facility's notification under any statute or regulation.

If the threat of a release is observed, the Team Leader must take the following actions: **[Required Activity]**

- Regroup, if necessary with the entire audit team at the facility management office;

- Inform the facility owner/operator of the observed situation; and

- If the facility owner/operator fails to take appropriate actions to mitigate the potential threat of release, the Team Leader must notify the Regional Emergency Response Section to apprise the OSC of events occurring at the facility.

In both of the above situations, notification to the Regional Emergency Response Section must be made regardless of whether the Team Leader or members of the audit team are OSCs. The communication with the region will determine the scope of the response action to be taken to mitigate the release or threat of release.

At this point, the audit must not continue until the release or threat of release has been mitigated, as determined by the OSC. The OSC and/or Remedial Project Manager (RPM) shall have the authority vested in them by the National Contingency Plan, 40

CFR Part 300. In addition, the OSC and/or RPM may take any necessary response actions when he/she determines that conditions at the site may present an imminent and substantial endangerment.

2.4 Relationship to Enforcement/Compliance Regulatory Programs

An EPA chemical safety audit is not an enforcement inspection or multi-media compliance audit, such as a RCRA compliance inspection or an environmental audit. Nor should an audit be confused with compliance inspections conducted by the Occupational Safety and Health Administration (OSHA) of the Department of Labor. A chemical safety audit is a visit to a facility to learn about and share technologies, techniques, and management practices for preventing and mitigating chemical accidents.

<u>Relationship to OSHA</u>

OSHA's primary responsibility is to protect workers, ensuring a safe and healthy environment for employees. OSHA conducts inspections to identify facility compliance with specific requirements and standards for employee health and safety and for accident investigations, especially where worker injuries or death occur. EPA and OSHA have established a Memorandum of Understanding on facility inspections, as well as coordinating activities through a variety of other means.

<u>Relationship to EPA Regulatory Programs</u>

The audit findings are presented in a final report. If appropriate, the report can include recommended process safety practices that the facility may want to consider adopting. Report findings and recommendations are not mandatory actions that the facility must adopt, as are those identified during an enforcement/compliance inspection. The audit focus is not on reviewing facility compliance with other regulatory programs; other media program offices already perform these activities. Use of CERCLA sections 104(b) and 104(e) provide EPA with the authority to enter a facility and access information for the purpose of conducting the safety audit.

Audit team members, however, will often consist of representatives from other EPA media program offices who are charged with the authority to conduct enforcement or compliance inspections and audits. In this situation, the role of this media program official must be determined prior to notifying the facility of the audit. **[Required Activity]** Facility notification involves citing the CERCLA entry and information gathering authorities. If this media program official intends to exercise authorities other than CERCLA sections 104(b) and 104(e), then the facility must be notified that these additional authorities will be exercised. In this situation, there are two separate EPA activities being conducted at the facility: a chemical safety audit and an enforcement/compliance inspection. This additional use of other authorities must be presented in the same letter that cites use of CERCLA authorities. **[Required Activity]** Facility notification procedures are presented in section 4.2 of this Manual.

During the conduct of a chemical safety audit that is not coupled with an enforcement inspection as presented above, program violations may be observed. These violations should be referred to the respective program office or federal agency/department for determination of what actions are to be taken following the audit.

2.5 Relationship Between CERCLA and SARA Title III

The CSA program is being conducted under CERCLA authority. While the idea of the CSA program originated from the activities undertaken to prepare the section 305(b) study mandated by Congress under SARA Title III (see the introduction to this Manual), and from similar audits conducted following catastrophic releases, there is no statutory link between the CSA program and the SARA Title III program.

The CERCLA and SARA Title III programs, however, have similar release notification provisions. A release or spill of a chemical above a certain threshold amount (the chemical's designated "reportable quantity" or "RQ") will often require two separate notifications: if the chemical is a CERCLA "hazardous substance," the National Response Center (NRC) must be notified under CERCLA section 103(a), and, if the chemical is a CERCLA hazardous substance and/or an "extremely hazardous substance" (EHS) under SARA Title III, the emergency coordinator of the local emergency planning committee(s) (LEPC) and the state emergency response commission(s) (SERC) likely to be affected by the release must be notified under SARA Title III section 304(a). CERCLA hazardous substances are listed at 40 CFR Part 302; EHSs under SARA Title III are listed at 40 CFR Part 355.

Although the two lists overlap considerably, they are not identical; approximately 138 EHSs are also CERCLA hazardous substances. It should be noted that all EHSs are proposed to be designated as CERCLA hazardous substances. In situations where the release is above the RQ of a chemical that is listed both as an EHS under SARA Title III and as a hazardous substance under CERCLA, notifications under both authorities must be given by the facility; this is because each notification is a separate requirement, and the contents and recipients of the notifications differ.

In addition, similar goals are shared by both the CSA program and the SARA Title III program. These include the following:

- Increased level of preparedness for responding to accidental releases of chemicals both at a facility and in a community;

- Increased awareness and understanding of chemical hazards; and

- Increased levels of safety practices related to producing, treating, handling, disposing, and transporting of hazardous substances at a facility.

Involvement in the CSA program by representatives of LEPCs and SERCs, either as audit team members, information sources, or both, is encouraged to enhance the goals of both these programs. However, state and local government participation in the audit, itself, must be performed under state and local authorities.

CHEMICAL SAFETY AUDIT PROGRAM

RESOURCE GUIDE

Prepared for:

Chemical Emergency Preparedness and Prevention Office
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency

Prepared by

ICF Incorporated

April 1991

CHEMICAL SAFETY AUDIT PROGRAM RESOURCE GUIDE

This Chemical Safety Audit (CSA) Resource Guide contains references to background and resource materials to help support the efforts associated with the CSA Program. The guide provides audit team members access to additional information to prepare for and conduct an audit and to write the audit report. The resources include books, journals, reports, and videos covering many topics in chemical safety. The guide contains information from various organizations, associations, and agencies such as the Environmental Protection Agency, the National Fire Protection Association, the Chemical Manufacturers Association, the American Institute of Chemical Engineers, the American Society of Safety Engineers, and the Occupational Safety and Health Administration.

Each reference lists the resource name, publisher or organizational sponsor, publication date, a short description of the document, information on obtaining the resource, and its cost. On the last page of this document is a list of organizations with frequent publications referenced in the resource guide. While this guide provides a comprehensive listing of resources, it is not an exhaustive list.

This guide follows the general format of the protocol found in the guidance manual of the Chemical Safety Audit Program. The protocol provides detailed guidance on the types of information that should be reviewed during an audit and discussed in the subsequent audit report. Resources are organized by each of the major areas of the protocol to assist audit team members in locating additional resource materials identified in this document. Audit team members can consult the resources applicable to specific topics or a particular focus of the audit. For example, an audit team member responsible for examining the public alert system in a facility can use the resources specified in this guide under the topic Public Alert and Notification Procedures.

This guide can be used at any time in the audit process. Consulting these resources in preparation for an audit can help the audit team members to conduct more informed and thorough investigations of the facility. Also, the resources can be used after an audit to compare facility practices with standard practices specified in the literature. In addition, the resources referenced in this guide may help in writing the audit report by validating facts and bolstering the report's technical credibility.

TABLE OF CONTENTS

1.0 GENERAL

Chemical Special Emphasis Program: Final Report, OSHA, March 1987

OSHA conducted forty Chemical Special Emphasis Program (ChemSEP) inspections on chemical manufacturing processes. This report indicates helpful aspects of a comprehensive approach to inspections, which includes management systems.

Available from OSHA/NIOSH as OSHA/RP-87/002. See last page for address and telephone number.

Conducting Fire Inspections: A Guidebook for Field Use, National Fire Protection Association, 1989.

This guidebook provides background information and inspection checklists for all types of occupancy to help ensure thorough inspections.

Available from National Fire Protection Association as Item No. FM-CFI-89 for $28.00. See last page for address and telephone number.

Inspection for Accident Prevention, First Edition, American Petroleum Institute, 1984.

This publication provides an overview of inspection methods practiced by petroleum refineries to prevent accidents at all levels, from the field to the equipment issue room. 11 pages.

Available from American Petroleum Institute as item # 855-20020 for $10.00. See last page for address and telephone number.

NFPA Inspection Manual, National Fire Protection Association, 1989.

This manual covers background facts and practical information about building features and NFPA codes and standards.

Available from the National Fire Protection Association as Item No. FM-IM-89 for $29.95. See last page for address and telephone number.

Plant/Operation Progress: articles on chemical process safety, American Institute of Chemical Engineers, July and October 1990.

These two monthly issues contain a series of articles on various strategies, issues, and technologies in chemical safety. Topics include management practice, process safety audits, public participation in risk assessment, and accident prevention.

Journal is available commercially or from libraries.

Recommendations to Chlor-Alkali Manufacturing Facilities for the Prevention of Chlorine Releases, Edition 1, The Chlorine Institute, Inc., October 1990.

This publication is intended to provide useful information to chlor-alkali manufacturing facilities to allow the organizations involved in such production to help comprehensively address the issue of preventing the occurrence, or minimizing the consequences, of uncontrolled releases of chlorine. It provides specific guidance in the development of a comprehensive process safety/risk management program.

Publication is available as publication #86 from the Chlorine Insitute for $7.00. See last page for address and telephone number.

Review of Emergency Systems, Environmental Protection Agency, 1988.

This document is a report to Congress on facility systems for monitoring, detecting, and preventing releases of extremely hazardous substances at facilities that produce, use or store them.

Available free of charge from EPA. See last page for address and telephone number.

Technical Safety Audit, F. Owen Kubias. Paper presented at Chemical Manufacturers Association Process Safety Management Workshop, May 5-7, 1985.

This paper describes the Technical Safety Audit process as designed by Glidden Co. to identify plant conditions, processing conditions or operating procedures which may lead to accidents. The audit uses checklists, raw materials evaluations, and "what if" analysis.

Available from the Chemical Manufacturers Association. See last page for address and telephone number.

"Total Plant Safety Audit," Jeff Conrad. Chemical Engineering, May 14, 1984, pp. 83-84, p. 86.

This article describes a hypothetical chemical plant safety audit, including a thorough evaluation of a plant's design, layout, appearance and operating procedures. It includes sample questions, a hypothetical audit team list, and advice on procedure evaluation and report follow-up.

Journal is available commercially or from libraries.

What Went Wrong? Case Histories of Process Plant Disasters, T.A. Kletz. Gulf Publishing Company, Houston, Texas, 1988.

This book examines the causes and aftermaths of noteworthy process plant disasters. It centers on recognition of danger signals and implementation of prevention methods.

Available as ISBN 0-87201-339-1 commercially or from libraries.

2.0 CHEMICAL HAZARDS

Flammable and Combustible Liquids Code Handbook, National Fire Protection Association, 1990.

This handbook provides guidelines to minimize flammable and combustible liquids risks, including expert commentary explaining and interpreting specific requirements.

Available from National Fire Protection Association as Item No. FM-30-HB90 for $49.50 See last page for address and telephone number.

Liquefied Petroleum Gases Handbook, National Fire Protection Association, 1989.

This handbook includes the entire text of Storage and Handling of LP-Gases, plus commentary and explanations to help apply requirements.

Available from National Fire Protection Association as Item No. FM-58HB89 for $49.50. See last page for address and telephone number.

Occupational Safety and Health Guidelines for Chemical Hazards, NIOSH, 1988.

This publication includes a compilation of the 35 occupational safety and health guidelines developed for the purpose of disseminating the information to workers, employers, and to professionals in the field of occupational safety and health.

Available from OSHA/NIOSH as DHHS/PUB/NIOSH-89-118-SUPPL-1-OHG. See last page for address and telephone number.

2.1 OVERVIEW OF HAZARDS FOR CHEMICAL(S) BEING AUDITED

Air Contaminants -- Permissible Exposure Limits (Title 29 Code of Federal Regulations Part 1910.1000), Occupational Safety and Health Administration, 1989.

This publication lists the updates of 29 CFR 1910.1000 after study of industrial experience and available scientific data. The revised personal exposure limits will protect workers against a wide variety of health effects. The final regulation includes 600 substances.

Available as OSHA 3112 free of charge from the Occupational Safety and Health Administration. See last page for address and telephone number.

<u>Basic Classification of Flammable and Combustible Liquids</u>, National Fire Protection Association, 1987.

This publication specifies physical and chemical properties of flammable and combustible liquids and establishes the classification system.

Available from the National Fire Protection Association as Item No. FM-321-87 for $13.25. See last page for address and telephone number.

<u>Classification of Class I Hazardous Locations for Electrical Installations in Chemical Plants</u>, National Fire Protection Association, 1986.

This document lists steps to determine the location, type, and scope of hazards presented by electrical installations in operations where flammable or combustible liquids are processed or handled..

Available from the National Fire Protection Association as Item No. FM-497A-86 for $15.50. See last page for address and telephone number.

<u>Classification of Gases, Vapors and Dusts for Electrical Equipment in Hazardous (Classified) Locations</u>, National Fire Protection Association, 1986.

This document provides group classifications for selected gases, vapors, and dusts to aid engineers in specifying the proper electrical equipment for hazardous (classified) locations.

Available from the National Fire Protection Association as Item FM-497M-86 for $13.25. See last page for address and telephone number.

<u>A Condensed Guide to Chemical Hazards (CHRIS I)</u>, U.S. Coast Guard.

This document provides chemical-specific information on 1,016 chemicals for hazard assessment and response techniques as applied to marine environments.

Available from U.S. Coast Guard as COMDTINST M16465.11A/SN#050-012-0024-0. See last page for address and telephone number.

<u>Dangerous Properties of Industrial Materials</u>, Irving Sax and Richard J. Lewis, Sr., American Society of Safety Engineers, 1988.

This reference book lists 20,000 chemicals and their exposure standards, including a Toxic Hazard Review section.

Available from the American Society of Safety Engineers as Order 8809 for $395.00. See last page for address and telephone number.

<u>Encyclopedia of Chemical Technology</u> (3rd. Edition), R.E. Kirk and D.F. Othmer. New York: John Wiley and Sons, 1980.

This encyclopedia consists of articles which describe the properties and manufacturing process of any substance. Those articles cross reference one or more articles where the uses of that substance are described. CAS numbers are included.

Available commercially or from libraries.

<u>Explosive Materials Code</u>, National Fire Protection Association 1990.

This publication identifies reasonable levels of safety for explosive materials.

Available from the National Fire Protection Association as Item No. FM-495-90 for $15.50. See last page for address and telephone number.

<u>Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids</u>, National Fire Protection Association, 1984.

This handbook provides a summary of available data on the fire hazard properties of more than 1,600 substances. Listed alphabetically with 500 synonyms.

Available from the National Fire Protection Association as Item No. FM-325M-84 for $17.50. See last page for address and telephone number.

<u>Fire Protection Guide on Hazardous Materials</u>, National Fire Protection Association, 1986.

This document lists hazard information and classification for most common hazardous materials.

Available from the National Fire Protection Association as Item No. FM-SPP-1E for $60.50. See last page for address and telephone number.

<u>Hawley's Condensed Chemical Dictionary</u>, revised by Irving Sax and Richard J. Lewis, Sr., American Society of Safety Engineers, 1987.

This publication provides a compendium of technical data on chemicals and chemical phenomena, chemical manufacturing equipment and components, energy sources and their potential, pollution, and waste control.

Available from the American Society of Safety Engineers as Order 8706 for $57.95. See last page for address and telephone number.

Hazardous Chemical Reactions, National Fire Protection Association, 1986.

This publication describes 3,500 recognized dangerous chemical reactions.

Available from the National Fire Protection Association as Item No. FM-491M-86 for $22.50. See last page for address and telephone number.

Hazardous Chemicals Data, National Fire Protection Association, 1987.

This publication specifies life and fire hazard precautions for chemicals which pose a health hazard, reactivity rating, or fire fighting problem.

Available from the National Fire Protection Association as Item No. FM-49-75 for $17.50. See last page for address and telephone number.

Hazardous Chemicals Desk Reference, Irving Sax and Richard J. Lewis, Sr., American Society of Safety Engineers, 1987.

This document is a quick-access guide with information on 4700 hazardous chemicals used in industry. Includes effects, synonyms, exposure limits.

Available from the American Society of Safety Engineers as Order 8717 for $79.95. See last page for address and telephone number.

NIOSH/OSHA Pocket Guide to Chemical Hazards, NIOSH/OSHA. U.S. Government Printing Office, 1985.

This book is a tabular-form quick-reference source relating to general industrial hygiene and medical surveillance practices. It gives chemical names and pseudonyms, exposure limits and recommendations, chemical and physical properties, analytical methods, respiratory and personal protection equipment recommendations, signs and symptoms of exposure, and procedures for emergency treatment.

This book is available as DHHS(NIOSH) Publication No. 85-114 from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402-9325

GPO Stock No. 017-033-00342-4

Rapid Guide to Hazardous Chemicals in the Workplace, Irving Sax and Richard J. Lewis, Sr., American Society of Safety Engineers, 1986.

This document provides an on-the-job guide to 700 hazardous chemicals, with hazard ratings, exposure standards and workplace control recommendations.

Available from the American Society of Safety Engineers as Order 8678 for $26.00. See last page for address and telephone number.

2.2 FACILITY MANAGEMENT OF CHEMICAL HAZARD DATA

Guidelines on Technical Management of Chemical Process Safety, the Center for Chemical Process Safety of the American Institute of Chemical Engineers, 1989.

This book describes twelve basic elements that must be considered in the development of a management system in the context of plant design, construction, operation, and management.

Available for $100.00 from the American Institute of Chemical Engineers. See last page for address and telephone number.

"Industrial Chemical Safety Testing: One Company's Approach," Y.H. Atallah and D.M. Whitacre. Ecotoxicology and Environmental Safety, vol. 4, No. 4., pp. 357-361, 1980.

This article reviews a testing program for the safety of industrial chemicals. The need for a testing program is discussed and the development of a three tier system to identify potentially hazardous chemicals is described. The criteria for defining the tiers are discussed, including the developmental stage of the product, route and magnitude of human exposure, magnitude of environmental exposure, and potential adverse health and environmental effects.

Journal is available commercially or from libraries.

3.0 PROCESS INFORMATION FOR HAZARDOUS CHEMICALS

Guidelines on Technical Management of Chemical Process Safety, the Center for Chemical Process Safety of the American Institute of Chemical Engineers, 1989.

This book describes twelve basic elements that must be considered in the development of a management system in the context of plant design, construction, operation, and management.

Available for $100.00 from the American Institute of Chemical Engineers. See last page for address and telephone number.

Instructional Videotapes on Chemical Process Safety, American Institute of Chemical Engineers, 1989.

These videotapes provide instruction on the application of safety procedures in plants and laboratories. The content is highly applicable to chemical process plants and is deemed useful for industrial training.

Available from AIChE as Pub. V-2 for $1250.00. See last page for address and telephone number.

Piping Design for Process Plants, Howard F. Rase. New York: John Wiley and Sons, inc. 1963.

This book describes and illustrates piping designs for various processes. It also includes standards for piping, pipe specification, fabrication, and arrangement.

Available at libraries (out of print).

Process-Control Systems: Application/Design/Adjustment, F.G. Shinskey. New York: McGraw-Hill Book Co., 1979.

This textbook describes theory and applications of chemical process systems. It centers on control and feedback systems.

Available as ISBN 0-07-0556891-X commercially or from libraries.

3.1 STORAGE AND HANDLING

Cleaning or Safeguarding Small Tanks and Containers, National Fire Protection Association, 1987.

This guide describes procedures for the safe removal of flammable vapors, liquids, gases, or solids from small tanks or containers that cannot be entered, and other safety measures.

Available from National Fire Protection Association as Item FM-327-87 for $13.25. See last page for address and telephone number.

Fire Protection Considerations for the Design and Operation of Liquified Petroleum Gas (LPG) Storage Facilities, First Edition, American Petroleum Institute, 1989.

This publication addresses the design, operation, and maintenance of liquified petroleum gas (LPG) storage facilities from the standpoint of prevention and control of releases, fire protection design, and fire control measures. The history of LPG storage facility failure, facility design philosophy, operating and maintenance procedures, and various fire protection and firefighting approaches are presented. The storage facilities covered are LPG installations (storage vessels and associated loading/unloading/transfer systems) at marine and pipeline terminals, natural gas processing plants, refineries, petrochemical plants, and tank farms. 35 pages.

Available from American Petroleum Institute as item # 855-25105 for $25.00. See last page for address and telephone number.

Fire Protection in Refineries, Sixth Edition, American Petroleum Institute, 1984.

This document centers on fire protection problems and steps to ensure the safe storage, handling, processing, and shipping of petroleum and petroleum products in refineries. The general principles mentioned in the publication are based in large measure upon composite experience in a large number of refineries. 31 pages.

Available from the American Petroleum Institute item # 855-20010 for $12.00. See last page for address and telephone number.

Flammable and Combustible Liquids Code, National Fire Protection Association, 1990.

This document lists updated requirements for storage and handling of flammable and combustible liquids.

Available from National Fire Protection Association as Item FM-30-90 for $17.50. See last page for address and telephone number.

General Storage, National Fire Protection Association 1990.

This publication describes requirements for the storage of the broad range of combustibles (Classes I through IV) and plastics (Groups A, B, and C).

Available from the National Fire Protection Association as Item No. FM-231C-186 for $15.50. See last page for address and telephone number.

Guidelines for Safe Storage and Handling of Highly Toxic Hazard Materials, Arthur D. Little, Inc. & Richard LeVine, American Institute of Chemical Engineers, 1987.

These guidelines are designed for engineers and technical personnel concerned with the safe manufacture and use of chemicals. Information is based on existing regulations, codes and standards in use worldwide as well as safety requirements developed by individual companies.

Available from AIChE as ISBN 0-8169-0400-6 for $80.00. See last page for address and telephone number.

Overfill Protection for Petroleum Storage Tanks, First edition, American Petroleum Institute, 1987

This publication suggests methods of preventing petroleum storage tanks from being overfilled and covers manual and automatic systems that provide protection against tank overfills, as well as safety, environmental protection, optimization of the work place, maintenance, and installation and training information. 21 pages.

Available from American Petroleum Institute as item # 855-23500 for $12.00. See last page for address and telephone number.

Packager Training Program, the Chlorine Institute, 1990.

This slide/video program is designed as a training tool for new and established employees at chlorine packaging plants. It gives a detailed view of the steps involved with tank car unloading, cylinder and ton container inspections, and valve reconditioning.

Available as "P-Slides" or "P-Video" from the Chlorine Institute for $200.00 (slides) or $175.00 (VHS video). See last page for address and telephone number.

Production, Storage, and Handling of Liquefied Natural Gas (LNG), National Fire Protection Association 1990.

This publication describes site selection, design, construction, and fire protection at LNG facilities.

Available from the National Fire Protection Association as Item No. FM-59A-90 for $15.50. See last page for address and telephone number.

Refrigerated Liquid Chlorine Storage, edition 1, the Chlorine Institute, July 1984.

This pamphlet provides information applicable to the design, construction, location, installation, and operation of refrigerated liquid chlorine storage systems.

Available as publication #78 from the Chlorine Institute for $7.00. See last page for address and telephone number.

Safe Handling and Storage of Compressed Gases, The Compressed Gas Association.

This audio-visual training program covers procedures for labeling and storage, precautionary safety warnings, personnel safety equipment, handling procedures, etc.

The Compressed Gas Association, Inc.
1235 Jefferson Davis Highway
Arlington, VA 22202-3269
703-979-4341

Available from the Compressed Gas Association on VHS, Beta, 3/4 inch, or slide format as item AV-1 for $140.

<u>Safe Tank Cleaning</u> (Audio-Visual Tape), American Petroleum Institute.

This tape covers the preparation, ventilation, and cleaning procedures of stationary petroleum and petrochemical storage tanks. Included in the program are: planning for tank cleaning, necessary permits, preferred ventilation methods, criteria for tank entry by personnel, flammability/toxicity hazards, and special considerations dictated by tank design and tank contents.

Available from American Petroleum Institute as title code 3401. See last page for address and telephone number.

<u>Storage and Handling of Liquefied Petroleum Gases</u>, National Fire Protection Association 1989.

This publication includes requirements for the safe storage and handling of LP-Gases, including systems, liquid transfer, truck transportation, engine fuel systems, and buildings or structures housing LP-Gas distribution facilities.

Available from the National Fire Protection Association as Item No. FM-58-89 for $17.50. See last page for address and telephone number.

<u>Storage and Handling of Liquified Petroleum Gases at Utility Gas Plants</u>, National Fire Protection Association 1989.

This publication describes safe design, construction, and operation of LP-Gas equipment at plants supplying LP-Gas/air mixtures for utility application.

Available from the National Fire Protection Association as Item No. FM-59-89 for $15.50. See last page for address and telephone number.

<u>Storage of Flammable and Combustible Liquids Within Underground Metal and Non-Metal Mines (Other than Coal)</u>, National Fire Protection Association, 1990.

This publication includes requirements for the safe storage of flammable and combustible liquids in underground mines other than coal mines. Includes information on the design, installation, inspection, and operation of storage facilities and equipment.

Available from the National Fire Protection Association as Item No. FM-122-90 for $13.25. See last page for address and telephone number.

Storage Vessels and Other Equipment, Series G: Design of Equipment, Volume 2, American Institute of Chemical Engineers, 1986.

This book consists of self-study modules designed to be used in independent study, continuing education courses, and traditional classes.

Available from AIChE as ISBN 0-816669-0409-X for $40.00. See last page for address and telephone number.

3.2 PROCESS DESCRIPTION

Atmospheric Monitoring Equipment for Chlorine, edition 4, the Chlorine Institute, February 1988.

This publication lists known equipment for monitoring chlorine concentrations at breathing zones and ambient environments.

Available as Publication #73 from the Chlorine Institute for $12.00. See last page for address and telephone number.

Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying, National Fire Protection Association, 1990.

This publication describes safety requirements for fans, ducts, duct clearances, design, and dust collecting systems for removal or conveying of flammable vapors, corrosive fumes, dust stock, and refuse.

Available from the National Fire Protection Association as Item No. FM-91-90 for $15.50. See last page for address and telephone number.

Chlorine Pipelines, edition 2, the Chlorine Institute, April 1982.

This pamphlet contains information on the transportation of gaseous and liquid chlorine in pipelines.

Available from the Chlorine Institute as publication #74 for $7.00. See last page for address and telephone number.

"Emergency Relief System (ERS) Design," Chemical Engineering Progress, August 1985, pp. 53-56.

This article describes a practical approach for estimating vent size and load requirements for downstream equipment. It is simple enough to be used by nonspecialist engineers and can be applied to virtually unknown systems.

Journal is available commercially or from libraries.

Industrial Process Design for Pollution Control, volumes 1-7, American Institute of Chemical Engineers, 1967-1975.

This series describes various process design strategies to minimize or control emissions.

Available from AIChE for $18.00 per volume. See last page for address and telephone number.

Mobile Lidar System Developments and Operating Procedures, George W. Bethke. EPA Environmental Sciences Research Lab, November 1979.

This report presents complete operating procedures for an improved system of analysis, presentation, and recording of smoke plume data.

Available from EPA (as document EPA 600/2-79-197) or NTIS (as PB80-132715). See last page for address and telephone number.

National Fuel Gas Code, National Fire Protection Association, 1990.

This document updates safety requirements for fuel gas equipment installations, piping, and venting. Provisions apply to all fuel gas systems on residential, commercial, and industrial premises using natural gas and LP-Gas at pressures up to and including 125 psi.

Available from the National Fire Protection Association as Item No. FM-54-88 for $19.50. See last page for address and telephone number.

Operation of Chlorine Vaporizing Equipment, edition 3, the Chlorine Institute, May 1987.

This publication contains information intended to assist in selection, design, and safe operation of vaporizers.

Available from the Chlorine Institute as publication #9 for $10.00. See last page for address and telephone number.

Piping Design for Process Plants, Howard F. Rase. New York: John Wiley and Sons, inc. 1963.

This book describes and illustrates piping designs for various processes. It also includes standards for piping, pipe specification, fabrication, and arrangement.

Available at libraries (out of print).

Piping Systems for Dry Chlorine, edition 5, the Chlorine Institute, March 1985.

This booklet contains information on selected pipes, valves, and fittings suitable for use with dry chlorine (gas or liquid).

Available as publication #6 from the Chlorine Institute for $10.00. See last page for address and telephone number.

Process Instruments and Controls Handbook, D.M. Considine, ed. McGraw-Hill, 1985.

This handbook consists of 83 separate articles in 19 chapters which cover temperature, pressure, flow, level, force, and other process systems and instruments. It examines various instruments for systems indication or control and explains their objectives, methods, and limitations.

Available as ISBN 0-07-012436-1 commercially or from libraries.

Process Operations, Series G: Design of Equipment, Volume 3, American Institute of Chemical Engineers, 1987.

This is a self-study module designed to be used in independent study, continuing education courses, and traditional classes.

Available from AIChE as ISBN 0-8169-0416-6 for $40.00. See last page for address and telephone number.

Remote Monitoring of Gaseous Pollutants by Differential Absorption Laser Techniques, S.A. Ahmed et. al. New York: City University of New York Dept. of Electrical Engineering. February 1980.

This report describes the single-ended laser radar (LIDAR) system for detecting pollutants.

Available from EPA (as document EPA 600/2-80-049) or NTIS (as PB80-179351). See last page for address and telephone number.

The State-of-the-Art Continuous Emission Monitoring Systems for Power Plants, J.A. Bamberger, ed., American Society of Mechanical Engineers, 1988.

This publication describes recent developments in Continuous Emission Monitoring and Systems for power plants.

American Society of Mechanical Engineers
22 Lawn Drive, Box 2300
Fairfield, New Jersey 07007-2300
201-882-1167, ext. 228

Available from ASME as Order No. H00441 for $16.00.

3.3 PROCESS HAZARDS

"Alarm and Shutdown Devices Protect Process Equipment," Edward J. Rasmussen. Chemical Engineering, May 12, 1975, pp. 74-80.

This article describes operating conditions and suitable applications for alarm and shutdown devices. It covers devices monitoring pressure, flow, level, temperature, and vibration.

Journal is available commercially or from libraries.

Control of Emissions from Seals and Fittings in Chemical Process Industries, Van Wagenen, Harold. OSHA/NIOSH, 1982.

This book describes methods and equipment to reduce fugitive emissions from seals and fittings.

Available as publication PB-82-188-988/A04 from NTIS. See last page for address and telephone number.

"Design for Process Safety," J.H. Tomfohode, Hydrocarbon Processing, December 1985, pp. 71-77.

This article examines a number of design items which frequently become the precursors of serious incidents. It reviews functional and safety considerations and potential vulnerabilities. Main topics include drains and vents, piping and equipment "pockets," small piping systems, piping and equipment pressure rating specification "breaks," and various safeguards.

Journal is available commercially or from libraries.

Electrical Installations in Hazardous Locations, National Fire Protection Association, 1988.

This publication is a working tool for inspectors, engineers, manufacturers, and safety professionals evaluating the safety of hazardous location electrical installations. Provides facts, and practical advice for solving problems involving for example, the prevention of ignition from static electricity and/or lightning.

Available from National Fire Protection Association as Item No. FM-HLH-88 for $49.50. See last page for address and telephone number.

International Symposium on Runaway Reactions, American Institute of Chemical Engineers, 1989.

This symposium focuses on basic considerations in chemical reactor stability, evaluating reactor system safety, and design and operating considerations for safe chemical reactor relief.

Available from AIChE as ISBN 0-8619-0460-X for $100.00. See last page for address and telephone number.

Plant/Operation Progress: articles on chemical process safety issue, American Institute of Chemical Engineers, July and October 1990.

These two monthly issues contain a series of articles on various strategies, issues, and technologies in chemical safety. Topics include management practice, process safety audits, public participation in risk assessment, and accident prevention.

Journal is available commercially or from libraries.

Prevention Reference Manual: User's Guide Overview for Controlling Accidental Releases of Air Toxics, D.S. David, G.B. DeWolf, and J.D. Quass. EPA Air and Energy Engineering Research Lab, July 1987.

The User's Guide, the first in a series of manuals, presents an overview of available methods for identifying, evaluating, and controlling hazards in facilities that use, manufacture, or store acutely toxic chemicals that could be released into the environment. Hazardous chemicals and their key characteristics are discussed, followed by a discussion of the potential hazards in process and physical plant design and in operational procedures.

Available from EPA (as document EPA 600/8-87-028) or NTIS (as PB 87-232112). See last page for address and telephone number.

"Safety-relief-valve malfunction: Symptoms, causes, and cures," William A. Scully. Chemical Engineering, August 10, 1981, pp. 111-114.

This article examines common problems with safety relief valves and lists four to twelve items to check in the event of leakage, chattering, and premature popping of valves

Journal is available commercially or from libraries.

4.0 CHEMICAL ACCIDENT PREVENTION

Loss Prevention, volumes 1, 2, 4, 5, 6, 7, and 11, American Institute of Chemical Engineers, 1967-1977.

These books discuss design strategies to prevent chemical releases

Available from AIChE for $22.00-$28.00. See last page for address and telephone number.

Plant/Operation Progress: articles on chemical process safety, American Institute of Chemical Engineers, July and October 1990.

These two monthly issues contain a series of articles on various strategies, issues, and technologies in chemical safety. Topics include management practice, process safety audits, public participation in risk assessment, and accident prevention.

Journal is available commercially or from libraries.

Review of Emergency Systems, Environmental Protection Agency, 1988.

This document is a report to Congress on facility systems for monitoring, detecting, and preventing releases of extremely hazardous substances at facilities that produce, use or store them.

Available free of charge from EPA. See last page for address and telephone number.

4.1 MANAGEMENT ACTIVITIES

Guidelines on Technical Management of Chemical Process Safety, the Center for Chemical Process Safety of the American Institute of Chemical Engineers, 1989.

This book describes twelve basic elements that must be considered in the development of a management system in the context of plant design, construction, operation, and management.

Available for $100.00 from the American Institute of Chemical Engineers. See last page for address and telephone number.

Hazardous Material Spills Conference Proceedings, American Institute of Chemical Engineers, 1988.

Conference proceedings from a Chicago, Illinois meeting on prevention, preparedness, and response. Papers deal with current developments in legislation, regulation, programs, and technology. Topics include emergency planning, disposal techniques, information management, computer applications, training, and prevention.

Available from AIChE as ISBN 0-8169-0453-7 for $85.00. See last page for address and telephone number.

Hazardous Waste and Emergency Response, Occupational Safety and Health Administration, 1989.

This 20-page publication discusses OSHA's requirements for hazardous waste operations and emergency response at uncontrolled hazardous waste sites and TSD facilities and summarizes the steps an employer must take to protect the health and safety of workers in these environments.

Available as OSHA 3114 free of charge from the Occupational Safety and Health Administration. See last page for address and telephone number.

"Implementing Process Safety Management Systems," Plant/Operations Progress, October 1990, p. 236.

This article provides guidelines for putting management procedures to work for process safety.

Available commercially from the American Institute of Chemical Engineers or from libraries.

National Occupational Exposure Survey, volume 3: Analysis of Management Interview Responses, OSHA/NIOSH. March 1988.

This volume provides analysis of industrial management responses to a questionnaire regarding occupational safety by industry and plant size. These analyses provide estimates of the numbers of employee and facilities in the US operating under specific management policies in the areas of safety and health.

Available from OSHA/NIOSH as DHHS/PUB/NIOSH-89-103. See last page for address and telephone number.

4.2 PROCESS OPERATION AND MAINTENANCE

Ammonia Plant Safety, volumes 13 through 29. American Institute of Chemical Engineers, 1971-1989.

This series consists of papers presented at the annual meetings of AIChE. They center on accidents, safety developments, and technical improvements pertaining to safety in the ammonia industry.

Available from AIChE for $28.00-$55.00. See last page for address and telephone number.

Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying, National Fire Protection Association, 1990.

This publication describes safety requirements for fans, ducts, duct clearances, design, and dust collecting systems for removal or conveying of flammable vapors, corrosive fumes, dust stock, and refuse.

Available from National Fire Protection Association as Item No. FM-91-90 for $15.50. See last page for address and telephone number.

Cleaning or Safeguarding Small Tanks and Containers, National Fire Protection Association, 1987.

This guide describes procedures for the safe removal of flammable vapors, liquids, gases, or solids from small tanks or containers that cannot be entered, and other safety measures.

Available from National Fire Protection Association as Item FM-327-87 for $13.25. See last page for address and telephone number.

"Safety-relief-valve malfunction: Symptoms, causes, and cures," William A. Scully. Chemical Engineering, August 10, 1981, pp. 111-114.

This article examines common problems with safety relief valves and lists four to twelve items to check in the event of leakage, chattering, and premature popping of valves.

Journal is available commercially or from libraries.

4.3 HAZARD EVALUATION AND MODELING

Engineering Applications of Risk Analysis, F.A. Elia, Jr., and A. Moghissi, American Society of Mechanical Engineers, 1988.

This book centers on understanding the concept of risk by the engineering profession, regulatory authorities, and the general public.

Available as Order No. G00438 for $20.00 through:

American Society of Mechanical Engineers
22 Lawn Drive, box 2300
Fairfield, New Jersey 07007-2300
201-882-1167, ext. 228

Environmental Fate of Chlorine in the Atmosphere, edition 1, the Chlorine Institute, April 1990.

This publication describes what happens to elemental chlorine when released into the air. This report was prepared by Alliance Technologies, Chapel Hill, North Carolina.

Available as publication #84 from the Chlorine Institute for $20.00. See last page for address and telephone number.

"Evaluating Emergency Response Models for the Chemical Industry," by Daniel J. McNaughton, Gary G. Worley, and Paul M. Bodner. Chemical Engineering Progress, January 1987, p. 46.

This article reviews the evaluation models and identification databases suitable for validating the models. Vaporization and dispersion models are among the models discussed.

Available commercially or from libraries.

Guideline on Air Quality Models (revised), Environmental Protection Agency, 1986.

This guideline recommends air quality modeling techniques that may be applied to air pollution control strategy evaluation and new source reviews, including prevention of significant deterioration. It is intended for use by EPA Regional offices in judging the adequacy of modeling analyses performed by EPA, by State and local agencies, and by industry and its consultants. It also identifies modeling techniques and data bases that EPA considers acceptable.

Available as EPA 450/2-78-027R free of charge from the Environmental Protection Agency or as PB86-245248 from the National Technical Information Service. See last page for addresses and telephone numbers.

Guidelines for Chemical Process Quantitative Risk Analysis, Center for Chemical Process Safety of the American Institute of Chemical Engineers. New York: American Institute of Chemical Engineers.

This book provides the tools for reducing acute risks in a chemical plant handling hazardous materials. It enables the manager or engineer to make quantitative estimates of risk.

Available as ISBN 0-8169-0402-2 from the American Institute of Chemical Engineers. See last page for address and telephone number.

Guidelines for Hazard Evaluation Procedures, prepared by Batelle Columbus Division for the Center for Chemical Process Safety of the American Institute of Chemical Engineers. ISBN # 0-8169-0399-9. New York: American Institute of Chemical Engineers, 1985.

This book centers on procedures for design, construction, and operation, including identification and analysis of hazards not easily identified from past experience. Largely, it lists qualitative procedures for hazard identification, although some of the procedures also can be used for quantitative analysis. The most significant aspect of this book is in helping to apply the proper hazard evaluation method to each process.

Available from the AIChE. See last page for address and telephone number.

<u>Guidelines on Risk Analysis</u>, edition 1, the Chlorine Institute, August 1989.

This publication provides information on the most recent safety concepts concerning risks posed in the chlor-alkali industry. It also defines risk analysis and how it is most applicable to the industry.

Available as publication #83 from the Chlorine Institute for $25.00 See last page for address and telephone number.

<u>Handbook of Chemical Hazard Analysis Procedures</u>, Federal Emergency Management Agency.

This book describes a wide range of planning activities for investigating the hazards in using and transporting dangerous chemicals. It includes methods to investigate local hazards, chemical fire hazards, probability analysis procedures, and planning for all types of hazardous materials releases.

Available from the Federal Emergency Management Agency. See last page for address and telephone number.

<u>Hazardous Materials Incident Analysis</u>, Federal Emergency Management Agency.

This 12-hour audiovisual course introduces a systematic method of analyzing and assessing the potential effect of hazardous materials involved in fires and other emergencies. Includes 454 color slides, 4 cassette tapes, 4 overhead transparency masters, and instructor's and student's guides.

Available for loan by the Chemical Manufacturers Association as Item A-04 at:

NCRIC
Chemical Manufacturers Association
2501 M Street, NW
Washington, DC 20037

<u>Major Industrial Hazards: Their Appraisal and Control</u>, John Withers, American Society of Safety Engineers, 1988.

This document presents methods of risk estimation, measurement of potential hazards against likely benefits, and other aspects of hazard evaluation.

Available from American Society of Safety Engineers as Order 8803 for $61.00. See last page for address and telephone number.

Managing Risk - Systemic Loss Prevention for Executives, Vernon L. Grose, American Society of Safety Engineers, 1987.

This publication presents risk analysis and cost with strong emphasis on bottom line performance.

Available from American Society of Safety Engineers as Order 8715 for $39.95. See last page for address and telephone number.

Proceedings of the International Conference on Vapor Cloud Modeling, Center for Chemical Process Safety of the American Institute of Chemical Engineers, 1987.

This book consists of proceedings of a conference held in Cambridge, Massachusetts from November 2-4, 1987. This book covers field-scale test modeling, source modeling, dispersion models, fire and explosion modeling, and other topics.

Available as ISBN 0-8169-0424-3 from the American Institute of Chemical Engineers. See last page for organization address and telephone number.

Profitable Risk Control: The Winning Edge, William Allison, American Society of Safety Engineers.

This publication centers on identifying risks to avoid accidents. Topics considered include performance measurements, hazard identification, loss control, and cost evaluation. Includes 100 release case histories, with causes and effective risk controls.

Available from American Society of Safety Engineers as Order 8667 for $35.00. See last page for address and telephone number.

Risk Assessment and Management: A Framework for Decision-Making, Environmental Protection Agency, 1984.

This report centers on risk assessment and risk management at EPA. It gives an overview of EPA's approach to decision-making for environmental toxic chemical problems.

Available as EPA IMSD/87-0002 from the National Technical Information Service. See last page for address and telephone number.

<u>Technical Guidance for Hazards Analysis: Emergency Planning for Extremely Hazardous Substances</u>, Environmental Protection Agency, 1987.

This guide provides technical assistance on the assessment of lethal hazards related to potential airborne releases of extremely hazardous materials. The purpose of the document is to assist local emergency planners in hazards analysis and specifically with local emergency planning requirements.

Available free of charge from the Emergency Planning and Community Right-To-Know Information Services. See last page for address and telephone number..

4.4 RELEASE PREVENTION SYSTEMS

"Alarm and Shutdown Devices Protect Process Equipment," Edward J. Rasmuss <u>Chemical Engineering</u>, May 12, 1975, pp. 74-80.

This article describes operating conditions and suitable applications for alarm and shutdown devices. It covers devices monitoring pressure, flow, level, temperature, and vibration.

Journal is available commercially or from libraries.

<u>Explosion Prevention Systems</u>, National Fire Protection Association 1986.

This publication provides requirements for explosion prevention systems based on reduced concentration of combustible material, as well as inert gas systems, explosion suppression systems, and pressure containment.

Available from National Fire Protection Association as Item No. FM-69-86 for $15.50. See last page for address and telephone number.

"Safety-relief-valve malfunction: Symptoms, causes, and cures," William A. Scully. <u>Chemical Engineering</u>, August 10, 1981, pp. 111-114.

This article examines common problems with safety relief valves and lists four to twelve items to check in the event of leakage, chattering, and premature popping of valves.

Journal is available commercially or from libraries.

4.5 MITIGATION SYSTEMS

1990 Emergency Response Guidebook/Guidebook for Hazardous Materials Incidents, U.S. Department of Transportation. U.S. Government Printing Office, 1990.

This is a guidebook for emergency service vehicles for incidents with hazardous materials. It includes advice for firefighters on extinguishing methods and standard procedures for initial actions to be taken to protect themselves and the public.

Available as DOT P 5800.4 from:

U.S. Department of Transportation
Materials Transportation Bureau, DMT-11
Washington, DC 20590

Evaluation of the Efficiency of Industrial Flares: Background-Experimental Design-Facility, D. Joseph et. al. Energy and Environmental Research Corp., August 1983.

The report summarizes the technical literature on the use of industrial flares and reviews available emission estimates. Technical critiques of past flare efficiency studies are provided.

Available from EPA (as document EPA 600/2-83-070) or NTIS (as PB83-263723). See last page for address and telephone number.

Guidelines for Vapor Release Mitigation, Richard W. Prugh, American Institute of Chemical Engineers, 1988.

These guidelines provide information to help development and communication of improved safety methods, practices, designs, and procedures in the chemical process industry.

Available from AIChE as ISBN 0-8169-0401-4 for $80.00. See last page for address and telephone number.

Hazardous Materials Response Handbook, National Fire Protection Association, 1989.

This handbook covers haz-mat standards, expert commentary, and supplements dealing with haz-mat response plans, decontamination, and team training.

Available from National Fire Protection Association as Item No. FM-472HB89 for $49.50. See last page for address and telephone number.

Installation of Air Conditioning and Ventilating Systems, National Fire Protection Association, 1989.

This publication specifies installation requirements for air conditioning and ventilating systems that restrict the spread of smoke, heat, and fire through duct systems, and minimize ignition sources.

Available from National Fire Protection Association as Item No. FM-90A-89 for $15.50. See last page for address and telephone number.

Release Containment in Chlorine Plants, edition 1, the Chlorine Institute, December 1983.

This pamphlet describes methods and techniques which have been commonly used in the chlorine industry to contain accidental chlorine releases which could possibly occur in chlorine production plants.

Available as publication MIR-147 from the Chlorine Institute for $2.00 See last page for address and telephone number.

Responding to Hazardous Materials Incidents, National Fire Protection Association, 1989.

This publication presents procedures and practices for mitigating incidents. Covers decontamination, methods of mitigation, chemical protective clothing, and safety.

Available from National Fire Protection Association as Item No. FM-471-89 for $15.50. See last page for address and telephone number.

"The Use of Water Spray Barriers to Disperse Spills of Heavy Gases," Kieth Moodie, Plant/Operations Progress, October, 1985, pp. 234-241.

This article describes the performance characteristics of full-scale water-spray barriers when dispersing accidental spills of heavy gases. Data from a series of trials establish that water spray barriers can achieve a worthwhile enhancement of the rate of dispersion and dilution of heavy gas spills.

Journal is available commercially or from libraries.

5.0 ACCIDENT RELEASE INCIDENT INVESTIGATION

Accident Investigation for Supervisors, Ted Ferry, American Society of Safety Engineers.

This is a guide for accident investigation on short notice with limited resources, and without major study. Includes systems approaches to accident investigation, organization, interviews, and reports.

Available from American Society of Safety Engineers as Order 8726 for $20.00. See last page for address and telephone number.

Accident Investigation Techniques, American Society of Safety Engineers, 1988.

This fifteen-minute audio-visual set describes key elements of the accident investigation process. Includes a leader's guide, script, cassette tape, point summary, and 70 slides.

Available from American Society of Safety Engineers as Order 8923 for $135. See last page for address and telephone number.

Investigating Accidents With STEP, Kingsley Hendrick and Ludwig Benner, Jr., American Society of Safety Engineers, 1987.

This guide serves as a model for accident investigation from initiation to follow-up actions.

Available from American Society of Safety Engineers as Order 8701 for $106.00. See last page for address and telephone number.

Modern Accident Investigation and Analysis, Ted Ferry, American Society of Safety Engineers, 1988.

This book centers on accident investigation as a management tool.

Available from American Society of Safety Engineers as Order 8502 for $57.50. See last page for address and telephone number.

6.0 FACILITY EMERGENCY PREPAREDNESS AND PLANNING ACTIVITIES

A Guide to the Safe Handling of Hazardous Materials Accidents, STP 825, American Society for Testing and Materials

This guide discusses Department of Transportation hazard classes, terms used in describing the classes or the materials, and incident control tactics. Includes a supplement, "Initial Emergency Assessment Initial Response Action."

Available from American Society for Testing and Materials as ISBN 0-803100261-5 or PCN 04-825000-31 for $24.00. See last page for address and telephone number.

How to Prepare for Workplace Emergencies, Occupational Safety and Health Administration, 1988.

This 12-page booklet details the basic steps needed to prepare the handle emergencies in the workplace. It is not intended to serve as an all-inclusive safety program, but rather to provide guidelines for planning for emergencies. It includes sections on evaluation, command, communications, and other topics.

Available as OSHA 3088 free of charge from the Occupational Safety and Health Administration. See last page for address and telephone number.

6.1 FACILITY EMERGENCY RESPONSE PLAN

Community Awareness and Emergency Response (CAER): The Next Phase, Chemical Manufacturers Association, 1990.

This document provides approaches and checklists for developing and implementing local community awareness and emergency response plans. Contains summaries of various approaches to coordinated emergency response planning.

Available for $15.00 from the Chemical Manufacturers Association. See last page for address and telephone number. Request by title.

Emergency Response Plans for Chlorine Facilities, edition 3, the Chlorine Institute, October 1990.

This publication includes information essential to the preparation or updating of formal, written emergency control plans applicable to chlorine-producing, chlorine-packaging, and chlorine-consuming facilities.

Available as publication #64 for $10.00 from the Chlorine Institute. See last page for address and telephone number.

"Emergency Response Procedures for Anhydrous Ammonia Vapor Release," Maurice L. Greiner. Ammonia Plan Safety and Related Facilities, American Institute of Chemical Engineers CEP Technical Manual v. 24 (1984), pp. 109-114.

This publication provides a detailed review of downwind ammonia vapor adsorption tactics, developed for firefighters. It includes a description of ammonia hazards and characteristics, case histories, and personal protection information.

Available from AIChE. See last page for address and telephone number.

Guide for Development of State and Local Emergency Operations Plans, Federal Emergency Management Agency, 1985.

This civil preparedness guide provides information for emergency management planners and for State and local government officials on FEMA's concept of emergency operations planning under the Integrated Emergency Management System.

Available as Document number CPG-1/Item #8-0044 free of charge from the Federal Emergency Management Agency. See last page for address and telephone number.

Guide for the Review of State and Local Emergency Operations Plans, Federal Emergency Management Agency, 1988.

This civil preparedness guide provides State Emergency Management Agency personnel with a practical and uniform means to identify provisions to be addressed in State and local emergency operations plans. It also provides FEMA personnel with a standard, comprehensive, and practical instrument to use in reviewing and determining the consistency of draft plans.

Available free of charge as CPG 1-8 from the Federal Emergency Management Agency. See last page for address and telephone number.

Hazardous Materials Response Handbook, National Fire Protection Association, 1989.

This handbook covers haz-mat standards, expert commentary, and supplements dealing with haz-mat response plans, decontamination, and team training.

Available from National Fire Protection Association as Item No. FM-472HB89 for $49.50. See last page for address and telephone number.

Preparing for Emergency Planning, National Association of Manufacturers, 1986

This is a guide for plant managers that describes basic provisions of hazardous substance laws.

Available from the National Association of Manufacturers as Catalog #046 for $21.95. See last page for address and telephone number.

A Primer for Preparedness for Acute Chemical Emergencies, Kathleen J. Tierney. Columbus: The Disaster Research Center of The Ohio State University, 1980.

This paper integrates social scientific research on planning for chemical emergencies with general community disaster planning. The result is a guide for community and facility action.

Available from the Disaster Research Center of The Ohio State University, Columbus, Ohio 43104.

6.2 EMERGENCY RESPONSE EXERCISES AND SIMULATIONS

Guide to Exercises in Chemical Emergency Preparedness Programs, Environmental Protection Agency, 1988.

This series of three bulletins provides an overview of the major types of exercises and describes some resources currently available for conducting exercises.

Available free of charge from the Emergency Planning and Community Right-To-Know Information Services. See last page for address and telephone number.

Hazardous Materials Exercise Evaluation Methodology (HM-EEM) and Manual, Federal Emergency Management Agency, 1989.

This two-part document is designed to assist State and local governments in the comprehensive evaluation of hazardous materials exercises. The document is the product of a year-long cooperative effort between FEMA Headquarters and its regional offices. It is a series of modules for the evaluation of 15 major exercise objectives covered by the plans prepared using FEMA's Hazardous Materials Emergency Planning Guide, or NRT-1.

Available as HM-EEM free of charge from the Federal Emergency Management Agency. See last page for address and telephone number.

Haz-mats! Case Studies for Emergency Responders, National Fire Protection Association, 1989.

This is a training film that centers on response procedures and strategies. This film uses four haz-mat emergencies to teach emergency response teams. Includes Instructor's Guide with reports, lesson plans, drills, and other materials.

Available from National Fire Protection Association as Item No. FM-FL-73 (Film) for $649.50, or Item No. FM-FL-73V (3/4 ", VHS, or Betamax videotape) for $549.50. See last page for address and telephone number.

6.3 FIRE, EVACUATION, AND RESCUE CORRIDORS

1990 Emergency Response Guidebook for Hazardous Materials Incidents, U.S. Department of Transportation. U.S. Government Printing Office, 1990.

This is a guidebook for emergency service vehicles for incidents with hazardous materials. It includes advice for firefighters on extinguishing methods and standard procedures for initial actions to be taken to protect themselves and the public.

Available as DOT P 5800.4 from:

U.S. Department of Transportation
Materials Transportation Bureau, DMT-11
Washington, DC 20590

Automatic Fire Detectors, National Fire Protection Association 1990.

This publication includes minimum performance, location, mounting, testing, and maintenance requirements of automatic fire detectors.

Available from National Fire Protection Association as Item No. FM-72E-90 for $19.50. See last page for address and telephone number.

Evacuation: An Assessment of Planning and Research, Federal Emergency Management Agency, 1987.

The purpose of this research was to assess issues and criticism of evacuation planning for all hazards under an integrated emergency management concept, and to review research that addresses those issues. The work identifies gaps in knowledge about evacuation planning issues and the research that could fill those gaps.

Available free of charge from FEMA as item # 8-0664. See last page for address and telephone number.

Evaluation of Firefighting Foams as Fire Protection for Alcohol Containing Fuels, First Edition, American Petroleum Institute, 1985.

This publication details the results of an API-sponsored study of the fire protection provided by fire fighting foams on fires containing alcohol or polar additives. These additives are known to be foam-destructive. This publication clarifies information on generic foam classes and application rates required to suppress fires involving these solvents, which are commonly added to unleaded gasolines. 71 pages.

Available from American Petroleum Institute as publication Publ 2309, item # 855-2300 for $17.00. See last page for address and telephone number.

Hazardous Chemicals Data, National Fire Protection Association.

This publication specifies life and fire hazard precautions for chemicals which pose a health hazard, reactivity rating, or fire fighting problem.

Available from the National Fire Protection Association as Item No. FM-49-75 for $17.50. See last page for address and telephone number.

Life Safety Code, National Fire Protection Association 1988.

This publication describes construction, protection, and occupancy features necessary to minimize danger to life from fire, smoke, fumes, and panic. Identifies criteria for the design of egress facilities to permit prompt escape from buildings, or where desirable, into safe areas within the building.

Available from National Fire Protection Association as Item No. FM-10188SB for $24.50. See last page for address and telephone number.

Portable Fire Extinguishers (Audio-Visual Tape), American Petroleum Institute.

This tape covers the design and operation of water, carbon dioxide, foam, halon, dry chemical, and dry powder extinguishers. Program also discusses fire-fighting techniques for portable extinguishers.

Available as Title code 3503 through:

Howell Training Company
5201 Langfield Road
Houston, TX 77040
1-800-527-1581

Proceedings of the Conference on In-Place Protection During Chemical Emergencies: November 30-December 1, 1988, U.S. EPA, FEMA, and Resources for the Future, 1989.

This book describes discussions and conclusions reached at a conference on in-place protection (i.e., going indoors and staying in). Results show that in-place protection may be more appropriate in certain instances of chemical release. The major aim of the conference was to begin to identify and develop guidance and training that the federal government can provide to local planners and responders for use in in-place protection. Sections discuss field experience, related research, industry perspective, public planning and preparedness, and emergency response.

Available for $4.00 from Resources for the Future, 1616 P Street, NW, Washington, D.C., 20046, or at 202-328-5060.

6.4 EMERGENCY EQUIPMENT PROVISIONS

"Emergency Response Procedures for Anhydrous Ammonia Vapor Release," Maurice L. Greiner. Ammonia Plan Safety and Related Facilities, American Institute of Chemical Engineers CEP Technical Manual v. 24 (1984), pp. 109-114.

This publication provides a detailed review of downwind ammonia vapor adsorption tactics, developed for firefighters. It includes a description of ammonia hazards and characteristics, case histories, and personal protection information.

Available from AIChE. See last page for address and telephone number.

Evaluation of Firefighting Foams as Fire Protection for Alcohol Containing Fuels, First Edition, American Petroleum Institute, 1985.

This publication details the results of an API-sponsored study of the fire protection provided by fire fighting foams on fires containing alcohol or polar additives. These additives are known to be foam-destructive. This publication clarifies information on generic foam classes and application rates required to suppress fires involving these solvents, which are commonly added to unleaded gasolines. 71 pages.

Available from American Petroleum Institute as publication Publ 2309, item # 855-2300 for $17.00. See last page for address and telephone number.

NFPA 11C: Mobile Foam Apparatus, National Fire Protection Association.

This document outlines the minimum requirements for the design, approval, testing, inspection, operation, and maintenance of mobile foam apparatus.

Available from National Fire Protection Association as Item No. FM-11C-90 for $13.25. See last page for address and telephone number.

NFPA 12: Carbon Dioxide Extinguishing Systems, National Fire Protection Association.

This document covers design, installation, testing, approval, operation and maintenance for total flooding, local application, and hose line systems.

Available from National Fire Protection Association as Item No. FM-11C-90 for $13.25. See last page for address and telephone number.

Personal Protective Equipment, Occupational Safety and Health Administration, 1990.

This 18-page booklet discusses those types of equipment most commonly used for protection of the head, including eyes and ears; the torso; arms and hands; and feet. The use of equipment to protect against life-threatening hazards is also discussed.

Available as OSHA 3077 free of charge from the Occupational Safety and Health Administration. See last page for address and telephone number.

Portable Fire Extinguishers (Audio-Visual Tape), American Petroleum Institute.

This tape covers the design and operation of water, carbon dioxide, foam, halon, dry chemical, and dry powder extinguishers. Program also discusses fire-fighting techniques for portable extinguishers.

Available as Title code 3503 through:

Howell Training Company
5201 Langfield Road
Houston, TX 77040
1-800-527-1581

Respiratory Protection, Occupational Safety and Health Administration, 1988.

This 15-page booklet presents information on respiratory equipment that complements relevant safety and health regulations and manufacturers' requirements.

Available as OSHA 3079 free of charge from the Occupational Safety and Health Administration. See last page for address and telephone number.

Standards on Vapor-Protective Suits for Hazardous Chemical Emergencies, National Fire Protection Association, 1990.

This document lists minimum design, performance, testing, and documentation requirements for vapor-protective suits for protection from exposure to specified chemicals in vapor and liquid splash environments.

Available from National Fire Protection Association as Item No. FM-1991-90 for $13.25. See last page for address and telephone number.

6.5 EMERGENCY RESPONSE CHAIN OF AUTHORITY

Hazardous Materials: Managing the Incident, by Gregory G. Noll, Michael S. Hildebrand, James G. Yvorra, 1988.

This textbook describes each step a command-level emergency responder must take to manage a haz-mat incident, including coordination with various other responders. Volumes available: Textbook ($25.00), Instructor's Guide ($15.00), and Workbook ($14.00).

Available by title from Fire Protection Publications. See last page for address and telephone number.

National Interagency Incident Management System: Incident Command System Position Manuals, 1989.

These booklets describe roles and responsibilities of various actors in the response to a hazardous materials incident. The volumes cover the Operations Section, Planning Section, Logistics Section, Command Section, and Finance Section of a response effort.

Available as a set for $20.00 from Fire Protection Publications. See last page for address and telephone number.

6.6 EMERGENCY RESPONSE MANAGEMENT PROCEDURES

The CEO's Disaster Survival Kit: a Common-Sense Guide for Local Government Chief Executive Officers, Federal Emergency Management Agency, 1988.

This book serves to assist CEOs in basic organization planning for an incident. It encourages the CEO to develop management tools and to plan for his or her roles and responsibilities in the event of a disaster.

Available as FA-91 free of charge from the Federal Emergency Management Agency. See last page for address and telephone number.

CHLOREP: Situation Assessment and Planning, National Safety Council.

This 15-minute VHS demonstrates CHLOREP, a procedure for alerting proper authorities and containing chlorine leaks.

National Safety Council
444 North Michigan Ave.
Chicago, Illinois 60611

Available from the National Safety Council as item No. 19010-2222 for $350.00.

"Emergency Response Procedures for Anhydrous Ammonia Vapor Release," Maurice L. Greiner. <u>Ammonia Plan Safety and Related Facilities</u>, American Institute of Chemical Engineers CEP Technical Manual v. 24 (1984), pp. 109-114.

This publication provides a detailed review of downwind ammonia vapor adsorption tactics, developed for firefighters. It includes a description of ammonia hazards and characteristics, case histories, and personal protection information.

Available from AIChE. See last page for address and telephone number.

<u>Evacuation: An Assessment of Planning and Research</u>, Federal Emergency Management Agency, 1987.

The purpose of this research was to assess issues and criticism of evacuation planning for all hazards under an integrated emergency management concept, and to review research that addresses those issues. The work identifies gaps in knowledge about evacuation planning issues and the research that could fill those gaps.

Available free of charge from FEMA as item # 8-0664. See last page for address and telephone number.

<u>Hazardous Materials Response Handbook</u>, National Fire Protection Association, 1989.

This handbook covers haz-mat standards, expert commentary, and supplements dealing with haz-mat response plans, decontamination, and team training.

Available from National Fire Protection Association as Item No. FM-472HB89 for $49.50. See last page for address and telephone number.

6.7 EMERGENCY COMMUNICATION NETWORK WITHIN THE FACILITY

<u>Installation, Maintenance, and Use of Notification Appliances for Protective Signaling Systems</u>, National Fire Protection Association, 1989.

This guide provides recommendations for the performance of notification appliances that are used with protective signaling systems.

Available from National Fire Protection Association as Item No. FM-72G-89 for $13.25. See last page for address and telephone number.

6.8 EMERGENCY RESPONSE PERSONNEL TRAINING REQUIREMENTS

Airport/Community Emergency Planning, National Fire Protection Association 1986.

This publication provides recommendations for emergency planning procedures, including how to plan for using personnel from all concerned agencies in an emergency and how to establish adequate emergency training programs.

Available from National Fire Protection Association as Item No. FM-424M-86 for $17.50. See last page for address and telephone number.

The Digest of Federal Training Programs in Hazardous Materials, Federal Emergency Management Agency, 1987.

This document is a catalog of information on all of the Federal training now available concerning hazardous materials.

Available as Document number FEMA 134/July 1987 free of charge from the Federal Emergency Management Agency. See last page for address and telephone number.

Guide for Fighting Fires in and Around Petroleum Storage Tanks, Second Edition, American Petroleum Institute, 1988.

This is a guide for training employees to successfully attack and extinguish various types of petroleum storage tank fires. 30 pages.

Available from American Petroleum Institute as item # 855-20210 for $8.00. See last page for address and telephone number.

Proceedings of the 1989 National Conference on Hazardous Materials Training, Federal Emergency Management Agency, 1989.

The purpose of the conference was to facilitate the exchange of ideas and information about hazardous materials training.

Available free of charge from FEMA as item # 6-0358. See last page for address and telephone number.

Professional Competence of Responders to Hazardous Materials Incidents, National Fire Protection Association, 1989.

This document lists training and capabilities that are required at various levels of response to hazardous materials incidents, including the First Responder Awareness and Operational levels; the Technical level; and the Specialist level. The Appendix deals with management of an incident.

Available from National Fire Protection Association as Item No. FM-472-89 for $13.25. See last page for address and telephone number.

6.9 FOLLOW-UP RELEASE PROCEDURES

Accident Investigation for Supervisors, Ted Ferry, American Society of Safety Engineers.

This is a guide for accident investigation on short notice with limited resources, and without major study. Includes systems approaches to accident investigation, organization, interviews, and reports.

Available from American Society of Safety Engineers as Order 8726 for $20.00. See last page for address and telephone number.

Modern Accident Investigation and Analysis, Ted Ferry, American Society of Safety Engineers, 1988.

This book centers on accident investigation as a management tool.

Available from American Society of Safety Engineers as Order 8502 for $57.50. See last page for address and telephone number.

7.0 COMMUNITY AND FACILITY EMERGENCY RESPONSE PLANNING ACTIVITIES

Community Awareness and Emergency Response (CAER) Resource Disk, Chemical Manufacturers Association, 1990.

This comprehensive resource guide for implementing the CAER process is stored on an IBM-compatible computer disk. Provides the CAER "Responsible Care Code of Management Practices" with examples of activities for each element, cross-referenced with associated printed and audio-visual materials. It also includes a database of CAER groups, SERCs, EPA, and OSHA offices. Specify 5 1/4-inch or 3 1/2-inch disk.

Available for $22.50 from the Chemical Manufacturers Association. See last page for address and telephone number. Request by title.

Plant/Operation Progress: articles on chemical process safety, American Institute of Chemical Engineers, July and October 1990.

These two monthly issues contain a series of articles on various strategies, issues, and technologies in chemical safety. Topics include management practice, process safety audits, public participation in risk assessment, and accident prevention.

Journal is available commercially or from libraries.

7.1 FACILITY PLANNING AND OUTREACH ACTIVITIES WITH COMMUNITY

Community Awareness and Emergency Response (CAER) Resource Disk, Chemical Manufacturers Association, 1990.

This comprehensive resource guide for implementing the CAER process is stored on an IBM-compatible computer disk. Provides the CAER "Responsible Care Code of Management Practices" with examples of activities for each element, cross-referenced with associated printed and audio-visual materials. It also includes a database of CAER groups, SERCs, EPA, and OSHA offices. Specify 5 1/4-inch or 3 1/2-inch disk.

Available for $22.50 from the Chemical Manufacturers Association. See last page for address and telephone number. Request by title.

<u>Community Awareness and Emergency Response (CAER): The Next Phase</u>, Chemical Manufacturers Association, 1990.

This document provides approaches and checklists for developing and implementing local community awareness and emergency response plans. Contains summaries of various approaches to coordinated emergency response planning.

Available for $15.00 from the Chemical Manufacturers Association. See last page for address and telephone number. Request by title.

<u>Emergency Response Plans for Chlorine Facilities</u>, edition 3, the Chlorine Institute, October 1990.

This publication includes information essential to the preparation or updating of formal, written emergency control plans applicable to chlorine-producing, chlorine-packaging, and chlorine-consuming facilities.

Available as publication #64 for $10.00 from the Chlorine Institute. See last page for address and telephone number.

<u>Plant Manager's Network Guide</u>, Chemical Manufacturers Association, 1990.

This booklet provides facility managers with ideas to develop outreach activities with their colleagues at nearby plants, or with leaders from other industries, to help the chemical industry become a visible, active, and valuable member of the community.

Available free of charge from the Chemical Manufacturers Association. See last page for address and telephone number. Pequest by title

<u>A Primer for Preparedness for Acute Chemical Emergencies</u>, Kathleen J. Tierney. Columbus: The Disaster Research Center of The Ohio State University, 1980.

This paper integrates social scientific research on planning for chemical emergencies with general community disaster planning. The result is a guide for community and facility action.

Available from the Disaster Research Center of The Ohio State University, Columbus, Ohio 43104

Proceedings of the Conference on In-Place Protection During Chemical Emergencies: November 30-December 1, 1988, U.S. EPA, FEMA, and Resources for the Future, 1989.

This book describes discussions and conclusions reached at a conference on in-place protection (i.e , going indoors and staying in) Results show that in-place protection may be more appropriate in certain instances of chemical release. The major aim of the conference was to begin to identify and develop guidance and training that the federal government can provide to local planners and responders for use in in-place protection. Sections discuss field experience, related research, industry perspective, public planning and preparedness, and emergency response.

Available for $4.00 from Resources for the Future, 1616 P Street, NW, Washington, D.C., 20046, or at 202-328-5060.

7.2 LOCAL/COMMUNITY EMERGENCY RESPONSE PLAN

Airport/Community Emergency Planning, National Fire Protection Association 1986.

This publication provides recommendations for emergency planning procedures, including how to plan for using personnel from all concerned agencies in an emergency and how to establish adequate emergency training programs.

Available from National Fire Protection Association as Item No. FM-424M-86 for $17.50. See last page for address and telephone number.

Chemical Emergency Preparedness Program: Interim Guidance. Washington, DC: Environmental Protection Agency. November 1985.

This document provides the public and state and local officials with information to assist them in planning how to respond to accidental releases of acutely toxic chemicals. Includes information on organizing the community, gathering site-specific information, contingency plan development, and contingency plan appraisal.

Available from libraries (out of print) as document EPA 560/7-85-012.

<u>Criteria for Review of Hazardous Materials Emergency Plans</u>, National Response Team of the National Oil and Hazardous Substances Contingency Plan, 1988.

This document provides guidance that may be used in the review of emergency response plans.

Available as document NRT-1A from the Emergency Planning and Community Right-To-Know Information Services. See last page for address and telephone number.

<u>Developing a Hazardous Materials Exercise Program: a Handbook for State and Local Officials (NRT-2)</u>, National Response Team, 1990.

This publication describes different types of response and planning exercises, how they are conducted, how to draw on them, and additional resources to help in preparing for emergency response. It includes step-by-step management exercises for decisionmaking.

Available free of charge as NRT-2 from the Emergency Planning and Community Right-To-Know Information Services. See last page for address and telephone number.

<u>Evacuation: An Assessment of Planning and Research</u>, Federal Emergency Management Agency, 1987.

The purpose of this research was to assess issues and criticism of evacuation planning for all hazards under an integrated emergency management concept, and to review research that addresses those issues. The work identifies gaps in knowledge about evacuation planning issues and the research that could fill those gaps.

Available free of charge from FEMA as item # 8-0664. See last page for address and telephone number.

Fire Service Emergency Management Handbook, International Association of Fire Chiefs.

This is a guide for fire chiefs and emergency medical personnel to strengthen planning and to aid effective emergency management at the community level. It includes principles of developing, evaluating, and revising community emergency planning activities; fire and emergency medical service responsibilities; and effective emergency management organization are covered. It also covers special problems such as funding and providing technical resources. Checklists for planning emergency situations are provided. 228 pages.

Available for $9.00 through:

International Association of Fire Chiefs Foundation
Suite 10B
101 East Holly Avenue
Sterling, VA 22170

Guide for Development of State and Local Emergency Operations Plans, Federal Emergency Management Agency, 1985.

This civil preparedness guide provides information for emergency management planners and for State and local government officials on FEMA's concept of emergency operations planning under the Integrated Emergency Management System.

Available as Document number CPG-1/Item #8-0044 free of charge from the Federal Emergency Management Agency. See last page for address and telephone number.

Guide for the Review of State and Local Emergency Operations Plans, Federal Emergency Management Agency, 1988.

This civil preparedness guide provides State Emergency Management Agency personnel with a practical and uniform means to identify provisions to be addressed in State and local emergency operations plans. It also provides FEMA personnel with a standard, comprehensive, and practical instrument to use in reviewing and determining the consistency of draft plans.

Available as CPG 1-8 free of charge from the Federal Emergency Management Agency. See last page for address and telephone number.

Hazard Identification, Capability Assessment, and Multi-Year Development Plan for Local Government, Federal Emergency Management Agency, 1987.

This publication lists instructions and forms for completing local Hazard Identification, Capability Assessment, and Multi-Year Development Plan.

Available free of charge from FEMA as item # 8-0423. See last page for address and telephone number.

Hazardous Materials Emergency Planning Guide, National Response Team, 1987.

This book, known as NRT-1, provides local authorities with a detailed overview of efforts required for selecting and organizing an emergency planning team, defining the tasks of that team, developing the plan and individual plan elements, and testing and maintaining the plan.

Available as NRT-1 free of charge from the Emergency Planning and Community Right-To-Know Information Services. See last page for address and telephone number.

Hazardous Materials: Managing the Incident, by Gregory G. Noll, Michael S. Hildebrand, James G. Yvorra, 1988.

This textbook describes each step a command-level emergency responder must take to manage a haz-mat incident, including coordination with various other responders. Volumes available: Textbook ($25.00), Instructor's Guide ($15.00), and Workbook ($14.00).

Available by title from Fire Protection Publications. See last page for address and telephone number.

Integrated Emergency Management Information System (IEMIS), Federal Emergency Management Agency.

This computer system combines a resource data base, multiple simulation models, communications, and color graphics to provide a fully integrated planning, exercising, and real-time tool for the management of accident and disaster response.

Available from the Federal Emergency Management Agency. See last page for address and telephone number.

National Interagency Incident Management System: Incident Command System Position Manuals, 1989.

These booklets describe roles and responsibilities of various actors in the response to a hazardous materials incident. The volumes cover the Operations Section, Planning Section, Logistics Section, Command Section, and Finance Section of a response effort.

Available as a set for $20.00 from Fire Protection Publications. See last page for address and telephone number.

Technical Guidance for Hazards Analysis: Emergency Planning for Extremely Hazardous Substances, Environmental Protection Agency, 1987.

This guide provides technical assistance on the assessment of lethal hazards related to potential airborne releases of extremely hazardous materials. The purpose of the document is to assist local emergency planners in hazards analysis and specifically with local emergency planning requirements.

Available free of charge from the Emergency Planning and Community Right-To-Know Information Services. See last page for address and telephone number.

8.0 PUBLIC ALERT AND NOTIFICATION PROCEDURES

"Alarm and Shutdown Devices Protect Process Equipment," Edward J. Rasmussen Chemical Engineering, May 12, 1975, pp. 74-80

This article describes operating conditions and suitable applications for alarm and shutdown devices. It covers devices monitoring pressure, flow, level, temperature, and vibration.

Journal is available commercially or from libraries.

Emergency Warning Systems Guidebook, Chemical Manufacturers Association, 1990.

This guidebook offers generic advice on types of warning systems available and guidelines for selecting a system. Compiled by industry representatives experienced in designing and implementing emergency warning systems and reviewed and approved by FEMA and the EPA.

Available for $7.50 from the Chemical Manufacturers Association. See last page for address and telephone number. Request by title.

Guide to Preparing Emergency Public Information, Federal Emergency Management Agency, 1987.

This guide is intended to assist those who prepare public information documents, and centers on improving the content and distribution of emergency preparedness messages.

Available as FEMA REP-11 from the Federal Emergency Management Agency. See last page for address and telephone number.

Installation, Maintenance, and Use of Notification Appliances for Protective Signaling Systems, National Fire Protection Association, 1989.

This guide provides recommendations for the performance of notification appliances that are used with protective signaling systems.

Available from National Fire Protection Association as Item No. FM-72G-89 for $13.25. See last page for address and telephone number.

Review of Emergency Systems, Environmental Protection Agency, 1988.

This document is a report to Congress on facility systems for monitoring, detecting, and preventing releases of extremely hazardous substances and to alert the public to a release.

Available from EPA. See last page for address and telephone number.

ALPHABETICAL INDEX OF REFERENCE TITLES

NIOSH/OSHA Pocket Guide to Chemical Hazards, 2.1 Overview of Hazards for Chemical(s) Being Audited -- p. 7.

Occupational Safety and Health Guidelines for Chemical Hazards, 2.0 Chemical Hazards -- p. 4.

Operation of Chlorine Vaporizing Equipment, 3.2 Process Description -- p. 15.

Overfill Protection for Petroleum Storage Tanks, First edition, 3.1 Storage and Handling -- p. 11.

Packager Training Program, 3.1 Storage and Handling -- p. 12.

Personal Protective Equipment, 6.4 Emergency Equipment Provisions -- p. 38.

Piping Design for Process Plants, 3.0 Process Information for Hazardous Chemical(s) -- p. 9, 3.2 Process Description -- p. 16.

Piping Systems for Dry Chlorine, 3.2 Process Description -- p. 16.

Plant Manager's Network Guide, 7.1 Facility Planning and Outreach Activities with Community -- p. 44.

Plant/Operation Progress: articles on process safety, 1.0 General -- p. 2, 3.3 Process Hazards -- p. 18, 4.0 Chemical Accident Prevention -- p. 20, 7.0 Community and Facility Emergency Response Planning Activities -- p. 43.

Portable Fire Extinguishers (Audio-Visual Tape), 6.3 Fire, Evacuation, and Rescue Corridors -- p. 36, 6.4 Emergency Equipment Provisions -- p. 38.

Preparing for Emergency Planning, 6.1 Facility Emergency Response Plan -- p. 33.

Prevention Reference Manual: User's Guide Overview for Controlling Accidental Releases of Air Toxics, 3.3 Process Hazards -- p. 18.

A Primer for Preparedness for Acute Chemical Emergencies, 6.1 Facility Emergency Response Plan -- p. 33, 7.1 Facility Planning and Outreach Activities with Community -- p. 44.

FREQUENTLY MENTIONED ORGANIZATIONS

American Institute of Chemical Engineers (AIChE)
Publications Sales, Dept. CAT-90
345 East 47 Street
New York, NY 10017
212-705-7657

American Petroleum Institute (API)
1220 L Street, NW
Washington, DC 20005
202-682-8375

American Society for Testing and Materials (ASTM)
1916 Race St.
Philadelphia, PA 19103-1187
215-229-5585

American Society of Safety Engineers (ASSE)
Department F
1800 East Oakton Street
Des Plaines, IL 60018-2187
708-692-4121 ext. 18

Chemical Manufacturers Association
2501 M Street, NW
Washington, DC 20037
202-887-1100

The Chlorine Institute, Inc.
2001 L Street, NW
Washington, DC 20036
202-775-2790

Federal Emergency Management Agency (FEMA)
Publications Office
P.O. Box 70274
Washington, DC 20024
202-646-2500

Fire Protection Publications
Oklahoma State University
Stillwater, Oklahoma 74078-0118
1-800-654-4055

National Association of Manufacturers (NAM)
Publications Coordinator
1331 Pennsylvania Avenue, NW
Suite 1500 - North Lobby
Washington, DC 20004-1703

National Fire Protection Association (NFPA)
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
1-800-344-3555

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
703-487-4650

Occupational Safety and Health Administration
U.S. Department of Labor
OSHA Publications Office, N3101
200 Constitution Avenue, NW
Washington, DC 20210
202-523-9667

U.S. Coast Guard
2100 Second Street, SW
Washington, DC 20593-0001

U.S. Environmental Protection Agency
Public Information Center
401 M Street, SW
Washington, DC 20460
202-382-2080

Emergency Planning and Community Right-To-Know Information Service
U.S. Environmental Protection Agency
OS-120
401 M Street, SW
Washington, DC 20460
1-800-535-0202

GROUP EXERCISES

Ground Rules and General Information

During the course of the workshop, four group exercises will be conducted. The exercises will allow the participants to practice the various phases of a chemical safety audit. The exercises build on one another. As part of the final exercise, each group will present a verbal audit report.

The exercises are based on a mock audit conducted at Facility X. Facility X manufactures urea from ammonia and carbon dioxide. The urea is then prilled (pelletized), coated, bagged, and sold as nitrogenous fertilizer. The chemical safety audit was triggered by a recent release of 500 pounds of ammonia.

Participants will be divided into groups of 5–7 individuals. Each group will conduct each of the following exercises:

- **Exercise 1 - Tuesday**—Facility X overview, information review, and hazards identification
- **Exercise 2 - Wednesday**—Process systems, operations, and maintenance interviews; information acquisition and interviewing techniques
- **Exercise 3 - Thursday**—Safety, training, and emergency response planning interviews
- **Exercise 4 - Friday**—Audit report preparation and presentation

The following information about Facility X will be provided:

1. A map indicating the position of the facility with respect to the surrounding community.
2. A facility map showing the layout of the equipment and major production areas.
3. A diagram of the urea manufacturing process.
4. A copy of the Tier II form submitted by the facility under Section 312 of SARA Title III.
5. A copy of the Accidental Release Information Program (ARIP) report submitted to EPA as a result of the ammonia release.
6. MSDS information on the chemicals used or produced in the urea manufacturing process.
7. An audit report worksheet.

Additional information will be provided during the exercise interviews.

Exercise 1—Facility X Overview, Information Review, and Hazards Identification

Exercise 1 starts with a facility overview, followed by team assignments and review of documentation. The purpose of the exercise is to establish the roles of each team member, review the written information about Facility X, identify facility chemical hazards, and complete Sections 1, 3, 4, and 5 of the audit report.

Tasks to be accomplished:

1. Establish roles (team leader, etc.) for all team members.

2. Identify any relevant chemical hazards and safety issues shown in the overview and Facility X written information.

3. Using the Chemical Safety Audit Manual and the Facility X written information, complete the following sections of the audit report: Section 1 - Introduction, Section 3 - Background, Section 4 - Facility Background Information, and Section 5 - Chemical Hazards.

4. Identify audit information that is needed for each additional section of the audit report.

5. Assign topics (e.g., safety, training, and process operations) to individual team members.

6. Identify possible sources of needed information.

7. As much as possible, establish information gathering objectives for each team member. The objectives are to be met during the Wednesday and Thursday exercises (Exercises 2 and 3).

TECHNICAL INFORMATION

ABOUT

FACILITY X

SOME FACTS ABOUT FACILITY X

1. Facility X is located in the northwest United States along the Pacific Coast. Some relevant weather data are:

Average temperature:	53°F
Average relative humidity:	73%
Mean wind speed:	7.9 miles per hour from ESE

2. The facility is 20 years old and employs 110 persons. The urea plant design capacity is 500 tons per day. Currently, it is operating at 70 percent capacity.

3. The audit was triggered by a series of releases of ammonia, the last one being approximately 500 lbs. (The reportable quantity for ammonia is 100 lbs.) The most recent ammonia release occurred because of a relief valve malfunction. The relief valve is set at a pressure 10 percent above the reactor pressure. The pressure increased, and the valve opened but failed to reseat.

4. The corporate safety person (a Vice President) is responsible for 22 plants located at various locations within the U.S.

5. The plant supervisor maintains records of the personnel who have attended training programs at the facility. Training programs include courses on employee safety, emergency response, and equipment operator certification.

This person also maintains all records of accident investigations, including accidental releases, and follows up each incident with the plant manager within 30 days to gather full details of investigations along with recommendations for improvement of safety.

In addition, this person was responsible for instituting an employee suggestion program to encourage safety-related suggestions accompanied by monetary rewards. In general, this person maintains a healthy attitude towards safety and maintains an open door policy.

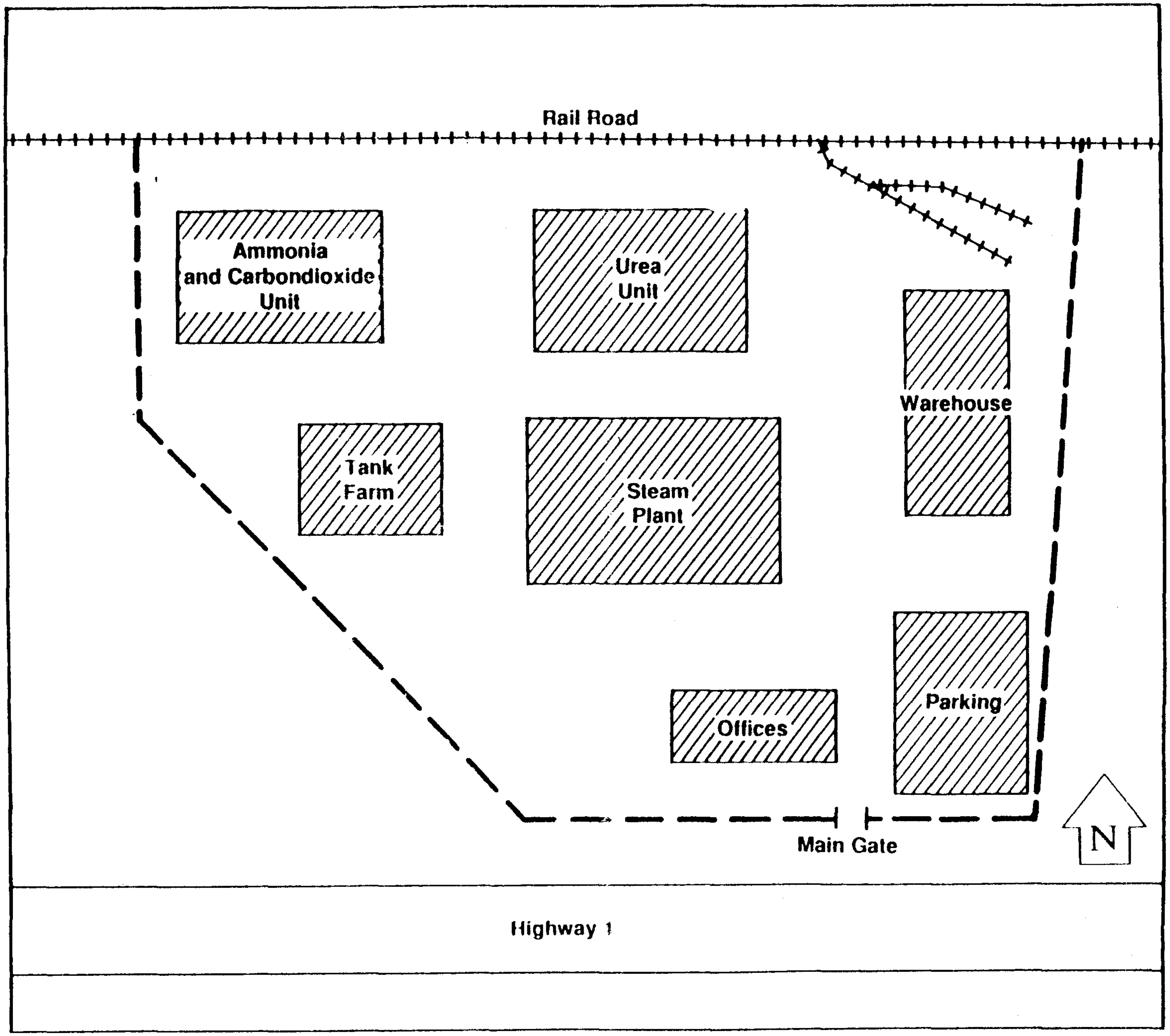
6. The corporate policy on hazards analysis requires that cause-consequences analyses or HAZOP be conducted on an annual basis. However, owing to budget constraints, such analyses have not been carried out at this plant.

7. Equipment maintenance at this plant is usually done on an as-needed basis. However, the plant conducts regular equipment inspections and testing as well as comprehensive investigations of equipment failures.

8. As an active member of CAER, emergency response plans at this facility are revised and updated every six months.

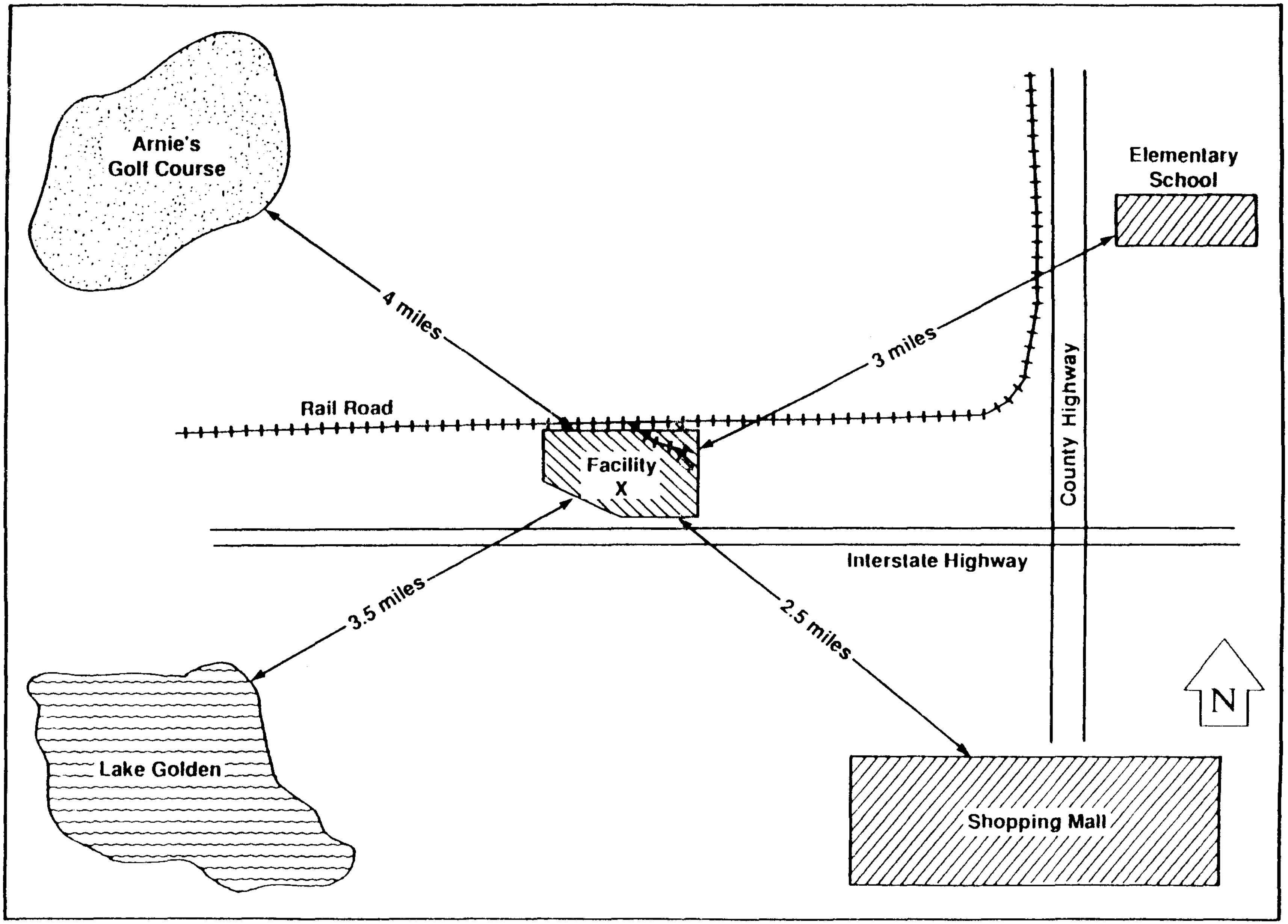
9. The plant has its own fully-equipped fire brigade.

Facility X

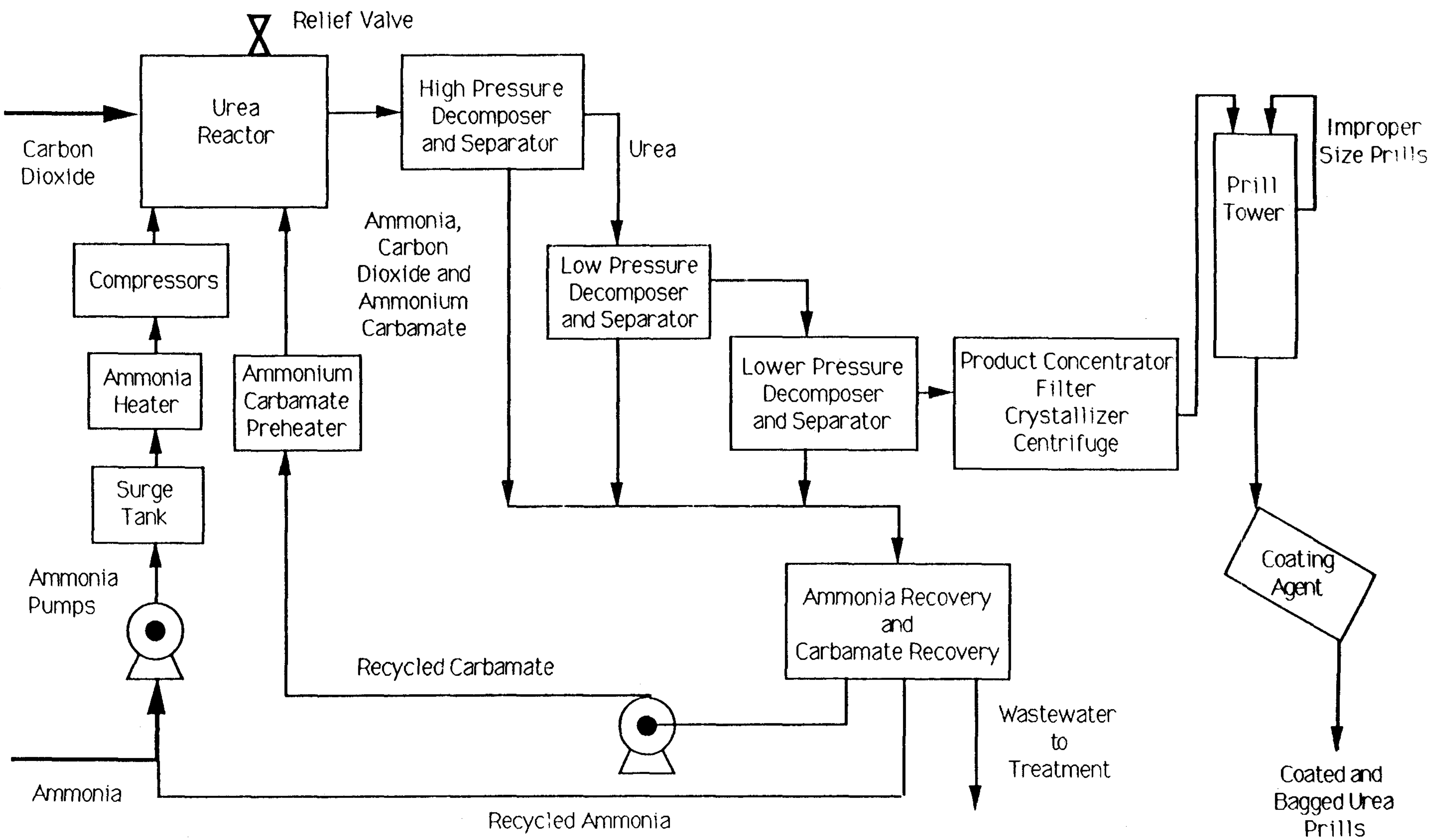


Rail Road
Ammonia
and Carbondioxide
Unit
Urea
Unit
Warehouse
Tank
Farm
Steam
Plant
Offices
Parking
Main Gate
N
Highway 1

Communities Around Facility X



FACILITY X
UREA MANUFACTURING PROCESS



Tier Two

EMERGENCY AND HAZARDOUS CHEMICAL INVENTORY

Specific Information by Chemical

Facility Identification

Name: Facility X
Street Address: 1 Industry St.
City: Pacific Town State: WA Zip: 99999
SIC Code: 2873 Dun & Brad Number: 01-0000-0001

FOR OFFICIAL USE ONLY
ID # 9
Date Received

Owner/Operator Name

Name: Bill Smith Phone: (806) 555-5555
Mail Address: 1 Industry St. Pacific Town, WA 99999

Emergency Contact

Name: Virginia Williams Title: Personnel Safety Manager
Phone: (206) 555-5555 24 Hr. Phone: (206) 555-6666

Name: Bill Smith Title: Plant Manager
Phone: (206) 555-5555 24 Hr. Phone: (206) 555-6666

Important: Read all instructions before completing form

Reporting Period From January 1 to December 31, 1989

Chemical Description	Physical and Health Hazards (check all that apply)	Inventory: Max. Daily Amount (code)	Inventory: Avg. Daily Amount (code)	Inventory: No. of Days On-site (days)	Storage Code	Storage Locations (Non-Confidential)
CAS 7664-41-7; Trade Secret [ ]; Chem. Name: Ammonia; Check all that apply: [x] Pure [ ] Mix [ ] Solid [x] Liquid [x] Gas	[x] Fire; [x] Sudden Release of Pressure; [ ] Reactivity; [x] Immediate (acute); [x] Delayed (chronic)	06	06	320	A 2 4	Tank farm 1 located 0.5 miles NW of main gate.
					C 2 4	Ammonia unit in Building 1 in NW corner of plant near railroad.
CAS 124-38-9; Trade Secret [ ]; Chem. Name: Carbon Dioxide; Check all that apply: [x] Pure [ ] Mix [ ] Solid [x] Liquid [x] Gas	[ ] Fire; [x] Sudden Release of Pressure; [ ] Reactivity; [x] Immediate (acute); [ ] Delayed (chronic)	06	06	320	A 2 7	Tank farm 2 located 0.5 miles NW of main gate.
					C 2 7	Carbon dioxide unit in Building 1 in NW corner of plant near railroad.
CAS 57-13-6; Trade Secret [ ]; Chem. Name: Urea; Check all that apply: [x] Pure [ ] Mix [x] Solid [ ] Liquid [ ] Gas	[ ] Fire; [ ] Sudden Release of Pressure; [x] Reactivity; [x] Immediate (acute); [ ] Delayed (chronic)	06	06	320	J 1 4	Warehouse next to railcar delivery on NE facility grounds
					J 1 4	Urea plant north of main gate near railroad.

Certification *(Read and sign after completing all sections)*

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete.

Bill Smith, Plant Manager
Name and official title of owner/operator OR owner/operator's authorized representative

Bill Smith
Signature

Date signed

Optional Attachments *(Check one)*

[ ] I have attached a site plan
[ ] I have attached a list of site coordinate abbreviations

Form Approved OMB No. 2050-0072

Tier Two

EMERGENCY AND HAZARDOUS CHEMICAL INVENTORY

Specific Information by Chemical

Facility Identification

Name: Facility X
Street Address: 1 Industry St.
City: Pacific Town State: WA Zip: 99999
SIC Code: 2873 Dun & Brad Number: 01-000-0001

FOR OFFICIAL USE ONLY — ID #: ____ Date Received: ____

Owner/Operator Name

Name: Bill Smith Phone: (806) 555-5555
Mail Address: 1 Industry St. Pacific Town, WA 99999

Emergency Contact

Name: Virginia Williams Title: Personnel Safety Manager
Phone: (206) 555-5555 24 Hr. Phone: (206) 555-6666

Name: Bill Smith Title: Plant Manager
Phone: (206) 555-5555 24 Hr. Phone: (206) 555-6666

Important: Read all instructions before completing form

Reporting Period From January 1 to December 31, 1989

Chemical Description	Physical and Health Hazards (check all that apply)	Inventory: Max. Daily Amount (code)	Avg. Daily Amount (code)	No. of Days On-site (days)	Storage Code	Storage Locations (Non-Confidential)
CAS: 506-87-6 Trade Secret: [ ] Chem. Name: Ammonium Carbamate Check all that apply: Pure [x] Mix [ ] Solid [x] Liquid [ ] Gas [ ]	Fire [x] Sudden Release of Pressure [ ] Reactivity [ ] Immediate (acute) [x] Delayed (chronic) [x]	06	04	320	R 2 5	Building 1 in NW corner of facility near railroad: Ammonium carbamate is intermediate in the process.
CAS: ____ Trade Secret: [ ] Chem. Name: ____ Check all that apply: Pure [ ] Mix [ ] Solid [ ] Liquid [ ] Gas [ ]	Fire [ ] Sudden Release of Pressure [ ] Reactivity [ ] Immediate (acute) [ ] Delayed (chronic) [ ]					
CAS: ____ Trade Secret: [ ] Chem. Name: ____ Check all that apply: Pure [ ] Mix [ ] Solid [ ] Liquid [ ] Gas [ ]	Fire [ ] Sudden Release of Pressure [ ] Reactivity [ ] Immediate (acute) [ ] Delayed (chronic) [ ]					

Certification *(Read and sign after completing all sections)*

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete.

Bill Smith, Plant Manager — Name and official title of owner/operator OR owner/operator's authorized representative

Bill Smith — Signature

____ Date signed

Optional Attachments *(Check one)*

[ ] I have attached a site plan
[ ] I have attached a list of site coordinate abbreviations

U.S. ENVIRONMENTAL PROTECTION AGENCY
ACCIDENTAL RELEASE PREVENTION QUESTIONNAIRE

INITIAL REPORT

SECTION I. FACILITY PROFILE

1. FACILITY NAME: Facility X

2. Dun & Bradstreet Number: |_|_|-|_|_|_|-|_|_|_|_|

3a. FACILITY MAILING ADDRESS:

1 Industry St.
Street

Pacific Town
City

Washington
State

99999
Zip Code

b.Facility physical address:

1 Industry St.
Street

Pacific Town
City

Washington
State

99999
Zip Code

4.

Latitude		Longitude	
DEG	MIN	DEG	MIN

5. NAME AND ADDRESS OF OWNER OR CHIEF EXECUTIVE OFFICER:

Bill Smith
Name

1 Industry St.
Street

Pacific Town
City

Washington
State

99999
Zip Code

6a. RESPONDENT:

Virginia Williams
Name

Personnel Safety Manager
Title

1 Industry St.
Street

Pacific Town
City

Washington
State

99999
Zip Code

(206) 555-6666
Telephone

b. DATE QUESTIONNAIRE COMPLETED: February 1990

7. Indicate the total number of employees typically at the facility (include all full-time and part-time employees, all employees on paid sick leave, paid holidays, paid vacations, managers and corporate officers at the facility). 110

8. Identify the four-digit Standard Industrial Classification (SIC) that best describes your facility operations and the primary product or service of this facility.

   a. SIC code: 2 8 7 3

   b. Primary product or service: Manufactures urea for nitrogenous fertilizer

   c. For facilities with multiple SIC codes, please identify the additional SIC codes.

   _ _ _ _, _ _ _ _

SECTION II. HAZARDOUS SUBSTANCE RELEASE PROFILE

The following section asks several questions concerning the accidental release of hazardous substances. If exact responses cannot be provided, please provide estimates using your best professional judgment.

9. Indicate the date release began.

_1_ _2_ - _1_ _2_ - _8_ _9_
(month) (day) (year)

Indicate date release ceased.

_1_ _2_ - _1_ _2_ - _8_ _9_
(month) (day) (year)

10. Indicate time of day release began.

_1_ _0_ : _4_ _0_
_X_ A.M.
__ P.M.

Indicate the time of day release ceased.

_1_ _1_ : _5_ _5_
_X_ A.M.
__ P.M.

11a. Check the item below that best describes the status of the process line where the event occurred **at the time of release.**

1. _X_ In operation
2. __ Temporarily inactive
3. __ Testing/Trial Run
4. __ Scheduled startup
5. __ Scheduled shutdown
6. __ New construction
7. __ During Maintenance
8. __ Production Changeover

b. Check the item below that best describes the **current status** of the process line where the event occurred.

1. _X_ In operation
2. __ Temporarily inactive
3. __ Permanently closed

If item 2 or 3 is marked, answer Question 11c; otherwise go to question 12.

c. Is the shut down of operations at the process line related to the accidental release of hazardous substances?

__ Yes
__ No

12a. Were federal authorities notified?

X Yes
__ No

b. If yes, please indicate which federal authorities were notified:

1. X National Response Center telephone number called (800) 424-8802

2. __ Coast Guard telephone number called ( )

3. __ EPA telephone number called ( )

4. __ Other (specify)

c. Indicate the date and time of day federal authorities were notified.

1 2 - 1 2 - 8 9 (Date)
(month) (day) (year)

1 2 : 5 5 (Time)
__ A.M.
X P.M.

13a. Were state authorities notified?

X Yes
__ No

b. If yes, identify all state authorities notified concerning the release. (If more than one, please attach list on separate page)

(Name) (Title)
Washington Emergency Response Commission
(Agency)
Olympia
(City)
Washington
(State)

(800) 633-7585
(Telephone)

c. Indicate the date and time of day state authorities were notified.

1 2 - 1 4 - 8 9 (Date)
(month) (day) (year)

0 9 : 0 0 (Time)
X A.M.
__ P.M.

14a. Were local authorities notified?

__ Yes
X No

b. If yes, identify all local authorities notified concerning the release. (If more than one, please attach list on separate page)

____
(Name) (Title)

____
(Agency)

____
(City)

____
(State)

( ) ______________________________
(Telephone)

c. Indicate the date and time of day local authorities were notified.

__ __ - __ __ - __ __ (Date)
(month) (day) (year)

__ __ : __ __ (Time)
__ A.M.
__ P.M.

15a. Was the general public notified?

__ Yes
X No

b. If yes, indicate the person that notified the general public of the release. (If more than one, please attach list on separate page)

____
(Name) (Title)

____
(Agency)

____
(City)

____
(State)

(____) ________________________
(Telephone)

16. For this particular release, what type(s) of communication technologies were used by the facility to alert and notify the public to evacuate or take other safety measures?

a. __ Door-to-door notification
b. __ Loudspeakers/public address system
c. __ Tone alert radio/pagers
d. __ Siren/alarms
e. __ Modulated power lines
f. __ Aircraft
g. __ Radio
h. __ Television
i. __ Cable override
j. __ Telephone
k. _X_ None
l. __ Other (please describe)

____
____
____

17a. Were members of the general public evacuated?

__ Yes
_X_ No

If yes, please indicate number evacuated.

__ __ __ __ __

b. Were members of the general public sheltered in place?

__ Yes
_X_ No

If yes, please indicate number sheltered in place.

__ __ __ __ __

18. To the best of your ability, indicate the weather conditions at the time of release for each item below. Approximations are acceptable.

a. Wind Speed (miles per hour) __ _7_._9_
b. Wind Direction _ESE_
c. Humidity (percent) __ _7_ _3_
d. Temperature (Fahrenheit) __ _5_ _3_
e. Precipitation? __ Yes _X_ No

19. Briefly describe the circumstances that led up to the release (if helpful include a sketch).

A system pipeline leading away from the reactor became partially blocked for unknown reasons. This resulted in a pressure buildup in the reactor. When the reaction vessel reached 10% above its normal operating pressure, the relief valve opened. Within a few minutes, the pressure returned to normal but the relief valve failed to reseat. In response to the release, the system was shut down, the relief valve was replaced, and the system lines were checked for blockages.

20. Please check the one item below that best describes the location of the release within your facility.

a. X Process vessel
b. __ Storage vessel
c. __ Valves on process vessel
d. __ Valves on storage vessel
e. __ Piping on process vessel
f. __ Piping on storage vessel
g. __ Pumps
h. __ Joints
i. __ Unknown
j. __ Other (please describe)

21. How was the release first discovered? (check as many as apply)

a. __ Indication by process control device (gauge or monitor)
b. __ Chemical specific detector
c. X General operator observation
d. __ Observation by foreman or supervisor
e. __ Injury/death
f. __ Explosion/fire
g. __ Major environmental damage
h. __ Third party notification (i.e., POTW, community, other facility)
i. __ Other (describe below)

22. Please check the one item below that best describes the **primary cause** of the release event. (please check one item only)

a. X Equipment failure
b. _ Operator error
c. _ Bypass condition
d. _ Upset condition (explain below)
e. _ Fire
f. _ Maintenance activity
g. _ Unknown
h. _ Other (Please describe)

23. Please check any items below that describe **additional causes** of the release event. (check as many items as apply)

a. _ Equipment failure
b. _ Operator error
c. _ Bypass condition
d. X Upset condition (elaborate below)
e. _ Fire
f. _ Maintenance activity
g. _ Unknown
h. _ Other (Please describe)

System overpressurization initially created the problem

24. Check the items that describe the end effects of the release event. (check as many as apply)

a. _ Spill
b. X Vapor release
c. _ Explosion
d. _ Fire
e. _ Other (describe)

25a. In the table below, please estimate the quantity of each substance released to each media. Be sure to specify the measurement unit.

Chemical	Media	Quantity	Unit
1a. Name Ammonia	Air	500	pounds
b. CAS # 7664-41-7	Surface Water		
c. Physical State Gas	Land		
	Sewer to Treatment Facility		
d. Concentration 100%			
2a. Name	Air		
b.CAS #	Surface Water		
c. Physical State	Land		
	Sewer to Treatment Facility		
d. Concentration			
3a.Name	Air		
b.CAS #	Surface Water		
c. Physical State	Land		
	Sewer to Treatment Facility		
d. Concentration			
4a. Name	Air		
b.CAS #	Surface Water		
c. Physical State	Land		
	Sewer to Treatment Facility		
d. Concentration			

b. Please check the items below that describe your methods or source of information for your responses in Question 25a. (check as many as apply)

X physical properties and ambient conditions
__ on-line instrument
__ engineering estimate
__ tank/system inventory
__ chemical analysis
__ effluent measured
__ inventory check
__ computer simulation
X process records
__ no release to media
__ other (please describe)

____

____

26a. Did any substances identified in Question 25, **migrate beyond the legal boundaries** of your facility (for example, a vapor release was carried by prevailing wind beyond the fence line of your facility)?

X Yes (If yes, please answer Question 26.b and c)
__ No (If no, skip Question 26.b and answer Question 26c)

b. In the table below specify the quantities of substances that **migrated beyond your facility boundaries.**

Chemical	Media	Quantity	Unit
1. Name: Ammonia	Air	500	pounds
	Surface Water		
	Land		
Physical state: Gas	POTW		
2. Name:	Air		
	Surface Water		
	Land		
Physical state:	POTW		
3. Name:	Air		
	Surface Water		
	Land		
Physical state:	POTW		
4. Name:	Air		
	Surface Water		
	Land		
Physical state:	POTW		

c. Please check the items below that describe your methods or source of information for your responses in question 26b.

X physical properties and ambient conditions
_ on-line instrument
_ engineering estimate
_ tank system inventory
_ chemical analysis
_ effluent measured
_ computer simulation
_ inventory check
_ process records
_ assumed
_ other (please describe)

____

____

27. Did injuries occur among facility employees or contractors as a result of the event?

_ Yes
X No

a. If yes, please indicate number of injuries.

_ _ _ _ _ _

b. How many of these received hospital treatment?

_ _ _ _

_ Number treated unknown

c. Did deaths occur among facility employees or contractors as a result of the event?

_ Yes
X No

If yes, please indicate number of deaths.

_ _ _ _ _ _

28. Did injuries occur among the general public as a result of the event?

_ Yes
X No
_ Don't know

a. If yes, please indicate number of injuries.

_ _ _ _ _ _

b. How many of these received hospital treatment?

_ _ _ _ _ _

__ Number treated unknown

c. Did deaths occur among the general public as a result of the event?

__ Yes
_X_ No
__ Don't know

If yes, please indicate number of deaths.

_ _ _ _ _ _

29. Please indicate the environmental effects that occurred as a result of the release:

a. __ Fish kills
b. __ Vegetation damage
c. __ Soil contamination
d. __ Groundwater contamination
e. __ Wildlife kills
f. _X_ None
g. __ Other (please specify)

____
____

SECTION III. CLEANUP AND PREVENTION PROFILE

30. Please describe the immediate response activities taken to contain or minimize the release.
Operators shut down the system and decided not to manually attempt to reseat the valve. Instead, the valve was replaced eventually, and the entire system was inspected for damage. Building fans helped to remove the released ammonia from the work areas.

31. Did your facility undertake cleanup of the release?

__ Yes (If yes, skip Question 32a.)
X No (NA)

32a. Please supply the name and address of the party responsible for cleanup.

(Name) (Title)

(Agency)

(City)

(State)

( )
(Telephone)

b. Has cleanup of the release been completed?

__ Yes (If yes, please answer Questions 32c.)
__ No (If no, please answer Question 32d.)

c. Indicate the date cleanup activity ceased.

__ __ - __ __ - __ __
(month) (day) (year)

d. Please indicate the approximate date completion of cleanup activity is expected.

__ __ - __ __ - __ __
(month) (day) (year)

33. How did you dispose of the waste generated during the spill and cleanup?
On site N/A

Off site N/A

34a. Prior to this release event, which types of **formalized hazard assessments** were performed? (Check as many items as apply). For those items checked, please indicate the frequency performed (i.e., quarterly, annually, one time, or on occasion).

	Frequency
X Cause–consequence analysis	annual*
_ Dow and Mond Hazard Indices	
_ Event tree analysis	
_ Failure modes, effects, and criticality analysis	
_ Fault tree analysis	
X HAZOP/hazard and operability studies	annual*
_ Human error analysis	
_ Probabalistic risk assessment	
_ What if analyses	
_ None	
_ Other (please describe)	

* Facility policy outlines annual hazard assessments, however, budget constraints have prevented conducting hazard assessments at this plant.

b. **What is your opinion of the effectiveness of each of the assessment techniques used?**
Both HAZOP and cause-consequence have been used at other corporate plants with great success. HAZOPs, although expensive to conduct, are particularly valuable for identifying hazards.

35. Prior to this release event, which of the following **pre-release controls** have been employed specifically to identify/prevent the type of release that occurred? (Check as many items as apply)

a. X Preventative maintenance
b. X Regular equipment inspections and testing
c. X Hazard assessment
d. _ Comprehensive audit
e. _ Regular assessment of equipment designs
f. X Process controls for operations monitoring and/or warning
g. _ Regular upgrading of equipment
h. _ Comprehensive investigation on similar equipment failure
i. X Standard operating procedures
j. _ Release prevention equipment
k. _ Equipment installation checks
l. _ Other (please describe)

36. Prior to this release, what **management activities** related to safety and loss prevention have been employed? (Check as many as apply)

a. X Employee safety training (e.g., OSHA training programs)
b. X Emergency Response training
c. X Employee testing
d. X Certification of operators on equipment/system
e. X Membership in CAER or other similar programs
f. X Release control program
g. X Accident investigation reports
h. __ Research/conferences
i. X Safety loss prevention office/officer
j. __ Corrective action process for deviation from rules
k. __ Program to improve system design
l. __ None
m. __ Other (please describe)

---

37. For this particular release, what method(s) of **pre–release protection equipment** (systems to capture, neutralize, or destroy a toxic chemical before it is released into the environment) is used by the facility? (Check as many items as apply)

a. __ Containment (i.e., diking, dump tank – explain below)
b. __ Neutralization
c. __ Scrubber
d. __ Flares/incineration
e. __ Adsorbers
f. __ Spray curtain
g. X Emergency Equipment (i.e., fire fighting)
h. __ None
i. __ Other (please describe)

---

38. For this particular release, what **systems or procedures** were employed by the facility to minimize accident potential? (Check all that apply)

a. __ Backup systems
b. __ Redundant systems
c. __ Minimize inventory
d. __ Valve lock out
e. __ Automatic shut off
f. __ Bypass and surge systems
g. __ Manual override
h. __ Limit capacity of equipment
i. X Standard Operating Procedures (logs, checklists)
j. X Alarms
k. __ Interlocks
l. __ None
m. __ Other (please describe)

---

39. In response to this release, which of the following pre-release controls have been implemented or modified to identify/prevent **future** potential releases? (Check as many as apply)

a. X Preventative maintenance
b. X Regular equipment inspections and testing
c. X Hazard assessment
d. __ Comprehensive audit
e. __ Regular evaluation of equipment designs
f. __ Increased process controls for operations monitoring and/or warning
g. __ Upgrading equipment
h. __ Revised standard operating procedures
i. __ Follow accident report investigation recommendations
j. __ Develop or refine emergency response planning
k. __ Other (please describe)

40. Describe the changes in the content of your training programs as a result of this release.

Training was believed to be adequate for this type of incident.

41. Describe the **immediate** equipment repairs and/or replacements, management practices, operational changes, etc. made as a result of the release.

The operators and maintenance crew replaced the relief valve, conducted a check on the proper operation of the valve, and inspected the system for damage.

42. What additional **long term** preventative measure(s) will be taken to minimize the possibility of recurrence?

The plant conducts more frequent inspection of relief valves.

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)* AMMONIA	*Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.*

Section I

Manufacturer's Name: Facility X	Emergency Telephone Number: (206) 555-6666
Address *(Number, Street, City, State, and ZIP Code)*: One Industry Street	Telephone Number for Information: (206) 555-5555
Pacific Town, WA 99999	Date Prepared: February 28, 1990
	Signature of Preparer *(optional)*

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Ammonia (NH_3)	TWA 50ppm	TWA 25ppm	IDLH 500ppm	
		STEL 35ppm	TPQ 500lbs	
			RQ 100lbs	

Section III — Physical/Chemical Characteristics

Boiling Point	-33° C	Specific Gravity (H_2O = 1)	Liquid: 0.68 @ -33° C
Vapor Pressure (mm Hg.)	400 @ -45°C	Melting Point	-78° C
Vapor Density (AIR = 1)	0.6	Evaporation Rate (Butyl Acetate = 1)	
Solubility in Water	31g / 100g @ 25° C		
Appearance and Odor	Colorless gas or liquid; sharp, cloying, repellant		

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
		16%	25%

Extinguishing Media
Small fires: dry chemical or carbon dioxide. Large fires: water spray, fog, or foam

Special Fire Fighting Procedures
Wear positive pressure breathing apparatus and full protective clothi

Unusual Fire and Explosion Hazards
Mixing of ammonia with several chemicals can cause severe fire hazards and/or explosions. Ammonia in container may explode in heat of fire.

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid Mixing with other chemicals and water
	Stable Yes		

Incompatibility (*Materials to Avoid*)
Strong oxidizers, calcium, hypochlorite bleaches, gold, mercury, silver, and halogens

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur Yes		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Yes Skin? Yes Ingestion? Yes

Health Hazards (*Acute and Chronic*)

Eye and respiratory tract irritant

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions
Generally Aggravated by Exposure

Emergency and First Aid Procedures

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Ventilate area of spill or leak to disperse gas. If in gaseous form stop flow of gas. If source of leak is a cylinder and cannot be stopped, remove to open air and repair leak or allow cylinder to empty. If in liquid form allow to vaporize.

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions
In case of release or spill, keep unneccessary people away, isolate hazard area and deny entry. Stay upwind out of low area. Evacuate area endangered by gas.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)
Positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air

Ventilation	Local Exhaust	Special
	Mechanical (*General*)	Other

Protective Gloves | Eye Protection

Other Protective Clothing or Equipment
respirator with escape SCBA and a fully encapsulating, chemical resistant suit.

Work/Hygienic Practices

☆U.S. Government Printing Office: 1987—181-504/64362

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)* Ammonium Carbamate

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name: Facility X	Emergency Telephone Number: (206) 555-6666
Address *(Number, Street, City, State, and ZIP Code)*: One Industry Street	Telephone Number for Information: (206) 555-5555
Pacific Town, WA 99999	Date Prepared: February 28, 1990
	Signature of Preparer *(optional)*

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Ammonium Carbamate ($CH_6N_2O_2$)	TWA	25ppm	IDLH 500ppm	
(limits as ammonia)	STEL	35ppm		

Section III — Physical/Chemical Characteristics

Boiling Point	Sublimates at 60° C	Specific Gravity (H_2O = 1)	
Vapor Pressure (mm Hg.)		Melting Point	
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water
Very soluble in water and ammonium hydroxide, slightly soluble in alcohol

Appearance and Odor
White, crystalline, rhombic powder; ammonia odor

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL

Extinguishing Media

Special Fire Fighting Procedures
For small fires, apply dry chemical, CO2, Halon, water spray, or standard foam. For large fires, apply water spray, fog, or standard foam.

Unusual Fire and Explosion Hazards
Evolves irritating fumes when heated

Fire may produce irritating or poisonous fumes

Section V — Reactivity Data

Stability			Conditions to Avoid
	Unstable		Very volatile
	Stable		

Incompatibility (*Materials to Avoid*)

Hazardous Decomposition or Byproducts
Decomposes in air to evolve ammonia

Hazardous Polymerization			Conditions to Avoid
	May Occur		
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Skin? Ingestion?

Health Hazards (*Acute and Chronic*)
Contact may cause burns to skin and eyes
Eye and respiratory tract irritant

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions Generally Aggravated by Exposure

Emergency and First Aid Procedures
In case of contact, immediately flush eyes with running water for at least 15 minutes. Wash skin with soap and water. Isolate contaminated clothing.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Stop leak if possible without risk. For small, dry spills, place material into clean, dry container and cover. For small spills, take up with absorbent material and place into covered container. For large spills, dike far ahead of liquid spill for later disposal.

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions
Keep unneccessary people away, isolate hazard area, and deny entry.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)
Self-contained breathing apparatus (SCBA) and structural firefighter's protective clothing

Ventilation	Local Exhaust	Special
	Mechanical (*General*)	Other

Protective Gloves	Eye Protection

Other Protective Clothing or Equipment

Work/Hygienic Practices

☆U.S. Government Printing Office: 1987—181-504/64362

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration
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OMB No. 1218-0072

IDENTITY (As Used on Label and List)	Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.
CARBON DIOXIDE	

Section I

Manufacturer's Name: Facility X	Emergency Telephone Number: (206) 555-6666
Address (Number, Street, City, State, and ZIP Code): One Industry Street	Telephone Number for Information: (206) 555-5555
Pacific Town, WA 99999	Date Prepared: February 28, 1990
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Carbon Dioxide (CO_2)	5,000 ppm	TWA 5,000ppm	IDLH 50,000ppm	
		STEL 30,000ppm		

Section III — Physical/Chemical Characteristics

Boiling Point	Sublimates	Specific Gravity (H_2O = 1)	Solid: 1.56 @ -79°C
Vapor Pressure (mm Hg.)	44061 @ 70°F	Melting Point	-79°C
Vapor Density (AIR = 1)	1.53	Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water: 0.14 % solubility in water

Appearance and Odor: Colorless, odorless gas

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL

Extinguishing Media

Special Fire Fighting Procedures: Not flammable

Container may explode in heat of fire -- move container or cool with water from the side

Unusual Fire and Explosion Hazards: Several bulk materials burn in carbon dioxide

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable		

Incompatibility (*Materials to Avoid*)
acrylaldehyde, metal acetylides, sodium peroxide, and chemically active metals -- sodium, potassium, and hot titanium

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Skin? Ingestion?

Health Hazards (*Acute and Chronic*) An asphyxiant, vapors may cause dizziness or suffocation

Contact with liquid may cause frostbite

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions
Generally Aggravated by Exposure

Emergency and First Aid Procedures Move victim to fresh air and call for emergency medical care; if not breathing, give artificial respiration; if breathing is difficult, give oxygen.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled Stop leak if possible without risk -- do not touch spilled material.

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions Keep unnecessary people away, isolate hazard area, and deny entry. Stay upwind out of low areas, and ventilate closed spaces before entering.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)
Self-contained breathing apparatus (SCBA) and structural firefighter's protective clothing

Ventilation	Local Exhaust	Special
	Mechanical (*General*)	Other

Protective Gloves	Eye Protection

Other Protective Clothing or Equipment

Work/Hygienic Practices

☆U.S. Government Printing Office: 1987—181-504/64362

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)* UREA	*Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.*

Section I

Manufacturer's Name: Facility X	Emergency Telephone Number: (206) 555-6666
Address *(Number, Street, City, State, and ZIP Code)*: One Industry Street	Telephone Number for Information: (206) 555-5555
Pacific Town, WA 99999	Date Prepared: February 28, 1990
	Signature of Preparer *(optional)*

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Urea (CH_4N_2O)				

Section III — Physical/Chemical Characteristics

Boiling Point: Decomposes		Specific Gravity (H_2O = 1): Solid: 1.34 @ 20°C	
Vapor Pressure (mm Hg.)		Melting Point: 133°C	
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water: Soluble in water, alcohol, and benzene; slightly soluble in ether

Appearance and Odor: White, tetragonal, needles or prism crystals; almost odorless with saline taste

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL

Extinguishing Media

Special Fire Fighting Procedures: Not flammable

Unusual Fire and Explosion Hazards

Section V — Reactivity Data

Stability			
	Unstable		Conditions to Avoid
	Stable		

Incompatibility (*Materials to Avoid*) Reacts explosively with sodium hypochlorite and calcium hypochlorite

Hazardous Decomposition or Byproducts Toxic decomposition products

Hazardous Polymerization			
	May Occur		Conditions to Avoid
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Skin? subcutaneous and intravenous Ingestion? Yes

Health Hazards (*Acute and Chronic*) skin irritant

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions Generally Aggravated by Exposure

Emergency and First Aid Procedures

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)

Ventilation		
	Local Exhaust	Special
	Mechanical (*General*)	Other

Protective Gloves | Eye Protection

Other Protective Clothing or Equipment

Work/Hygienic Practices

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Exercise 2—Process Systems, Operations, and Maintenance Interviews and Interviewing Techniques

This exercise covers interviewing selected facility personnel and completing the following sections of the audit report: Section 6 - Process Information and Section 7 - Chemical Accident Prevention. The exercise begins with members selected from each audit team interviewing Facility X operating and maintenance staff, including a maintenance foreman, an operations foreman, the operator who was on duty at the time of the ammonia release, and the fire brigade commander.

Interviewing procedure:

1. Interviews with each Facility X employee will be conducted in front of the entire class.

2. Each Facility X employee will be interviewed by representative(s) from each team.

3. To ensure maximum fairness during the exercise, interviews will be conducted in rounds. Each audit team will be allowed three questions plus one follow-up question per round. The rounds will continue until there are no further questions for the employee.

Upon completion of questioning, a short critique will be conducted. The critique will focus on interviewing technique strengths and weaknesses displayed during the interviews.

Short follow-up interviews will be allowed. These interviews will be conducted in the presence of all workshop participants.

Tasks to be accomplished:

1. Perform Facility X employee interviews with the operations foreman, the fire brigade commander, the maintenance foreman, and the operator on duty at the time of the ammonia release.

   Possible interview topics include, but are not limited to:

   - Facility standard operating procedures
   - Response activities relating to the ammonia release
   - Maintenance philosophy and procedures
   - Specific maintenance activities relating to the ammonia release
   - Emergency response procedures, etc., needed to complete the chemical safety audit report.

2. Reassemble the team and evaluate the information obtained from the facility overview and the interviews. Reinterview facility employees as needed.

3. Complete Section 6 - Process Information and Section 7 - Chemical Accident Prevention of the audit report.

TIPS FOR CONDUCTING AN EFFECTIVE INTERVIEW

SETTING THE CLIMATE

1. **Decide where to conduct the interview**—Talking about safety issues with federal officials can be threatening and create defensiveness in some plant managers or employees. Therefore, the physical setting for the meeting is an important consideration. Several options that can alleviate some tension for the interviewee include:

   - Conduct the interview in an informal setting in an office
   - Conduct the interview in a conference room
   - Conduct the interview outside the plant
   - Conduct the interview on the plant floor in a convenient location for the employee.

   Try to determine where the interviewee will be most relaxed and undistracted.

2. **Establish the proper tone**—Prepare for each interview by writing down an opening statement that breaks the ice and sets a comfortable, positive tone for the meeting. A relaxed and open atmosphere will significantly improve the quality of the discussion.

3. **Clarify why you are meeting**—Make a clear statement at the beginning of the interview about why you are meeting and what you hope to accomplish.

4. **Monitor nonverbal cues**—In addition to setting an appropriate tone for the interview, you should reflect this tone physically. It is hard to sound relaxed, open, and supportive if your body position is conveying that you are uptight and uncomfortable. During the first moments of the interview, monitor the way you are sitting, your voice, and your body language and relax as needed.

GETTING DOWN TO BUSINESS

1. **Ask effective questions**—Questions are the basic vehicle for obtaining information during an interview. There are several types of questions you can use.

   - **Open questions** invite the interviewee to express his or her opinion about an issue (e.g., "What is involved in your plant's HAZOP analysis?"). Open questions begin with phrases such as *What do you know about. . ., Describe for me the way. . .,* and *How would you. . .* Open questions are used to ask people to describe, explain, or expand on a topic.

   - **Closed questions** ask the interviewee to state where he or she stands on an issue (e.g., "Which database system would you use?"). Closed sentences begin with *do, which, where,* or *who* and ask the interviewee to make a choice or state a preference.

- **Leading questions** suggest the answer the interviewer expects to receive. This type of question should be avoided.

- **Mirror questions** repeat or reflect information you have already received for which you desire confirmation or clarification. They begin with *Let me see if I understand...*, *Can you tell me what you meant by...*, and *In other words...*

- **Loaded questions** use words that may trigger defensive or emotional responses. This type of question should also be avoided.

2. **Listen actively**—An essential ingredient of a successful interview is to listen actively to the interviewee's point of view. To listen actively, you must concentrate on what the other person is saying, rather than catching the "gist" of what is said. To ensure that you are listening accurately, periodically summarize what the other person has said. You can use phrases beginning with *So what you are saying is...*, or *Your concern is that...*, or summarize the topic in your own words.

3. **Seek clarification**—There will be times during the interview when you think you know what the interviewee has in mind, but you may not be certain. When in doubt, don't assume you understand. Ask a question or summarize what the individual has said so you will be certain you understand their intent. Questions such as *How would you do that?* or *So what you are suggesting is...* may provide the necessary clarification.

4. **Handle disagreements**—During the interview, you may disagree with the interviewee. If this happens, be direct and explain why you disagree with them. Use an example to illustrate your point. After you have given your explanation, ask the interviewee if he or she understands your point of view. Don't let a disagreement prevent you from obtaining the information you need.

CONCLUDING THE INTERVIEW

1. **Summarize the discussion**—To ensure that both you and the interviewee have the same understanding of the topics you have discussed, wrap up the conversation by recapping the key issues and findings of the interview and asking for any final comments.

2. **Decide on follow-up**—As the interview concludes, determine whether specific follow-up steps are needed (e.g., obtaining additional information or consulting other employees). Next, determine who is going to be responsible for the action, the time frame for the action, and the expected results.

3. **Obtain commitment**—Once the need for follow-up is established, decide (with your interviewee) on the most appropriate format (e.g., telephone call, meeting, or other) and establish a time for completion.

KEY FACILITY PERSONNEL AND FEATURES

PLANT AND CORPORATE PERSONNEL

When conducting an interview, you will meet and interact with several industry personnel, each with different information or concerns related to your visit. The following personnel positions may be represented at a facility you visit:

- **The plant manager**—The most important person at the site. The plant manager is responsible for the workday safety and well-being of the plant's employees and for the impact of operations on the surrounding community. He or she is also responsible for the viability of the business and plant site. The plant manager will likely attend both the kickoff and the exit meetings with your team. These meetings will include his or her staff and may also include personnel from corporate staff.

- **Legal counsel**—A company lawyer can reasonably be expected to get involved in the site visit portion of the audit. The lawyer could be a member of the plant manager's staff, in which case he or she would handle a range of issues, such as taxes and licenses, workers compensation, environmental permits and compliance, and customer legal issues. This lawyer could, however, be from corporate headquarters, and in a large company he or she would handle a narrower range of issues, primarily dealing with safety and environment. With respect to your visit, the company lawyer will be interested in the maintenance of confidentiality and in the legal standing of your requests for information.

- **Operations staff**—It is highly likely that you will meet other engineers, foremen, operators, and technicians while touring the plant operating areas. Middle managers and, perhaps, junior staff will participate in your visit because of their day-to-day involvement with the plant's operation from a people, process, and equipment perspective. These people may be asked by your tour guides to discuss or demonstrate particular aspects of the operation for which they have a hands-on role. For example, you may see a demonstration of an alarm system, or the operation of an important process control instrument may be explained.

- **Corporate staff**—Personnel representing a parent corporate entity will likely be present during your visit. Corporate involvement will depend on corporate management policy and the amount of public awareness and media attention focused on the facility. Corporate level staff that may be present could include managers active in developing both corporate and public safety policy, as well as engineers and scientists who provide company-wide expertise ranging from new process design to audits and troubleshooting.

PLANT SOURCES AND SURVEY-RELATED INFORMATION

An important task for the team will be to determine who, among all those you meet, can best provide the information you seek. All of the people you will come into contact with will have, at least in part, a functional health and safety focus to their jobs. This focus can range from site or process specific to worldwide (including government affairs). Based on the major areas of inquiry reflected in the audit protocol, the following company staff will likely be the most helpful:

Desired Information	Personnel to Contact
Facility information	Plant manager, safety personnel
Hazard assessments	Safety personnel, technical staff
Prevention, monitoring, and mitigation Manufacturing	Technical staff, safety personnel
Release monitoring and detection	Manufacturing and safety personnel, environmental staff
Modeling	Safety personnel, technical staff, corporate technology
Public alert	Safety personnel, public relations

Understanding the roles and responsibilities of these company employees, their interests, and how they relate to one another will help you communicate effectively and get your job accomplished. Remember:

> Know your sources. Because you will be gathering information during your interactions with many different plant personnel, it is important to establish where in the organization they fit and what their overall function is relative to the information they are providing.

Knowledge of personnel and responsibilities can greatly enhance your team's position. For example:

- You can garner a measure of respect from your hosts, which can translate into acceptance

- You can learn much from the way they interact, which will facilitate your inquiry.

A precautionary note: It is important to work with the appropriate plant personnel. If the plant does not have a clear understanding of your mission, you may meet many people who are not well matched to your needs.

PLANT FEATURES OF PARTICULAR INTEREST

As part of your audit, you will be shown many areas of the plant and see many items relating to your objective. You should be able to request to see those items you feel are important to your understanding of the situation. Places you may enter or items you may see could include the following:

- **Office of the plant safety officer**—Wall chart tracking systems and plant layouts organized to emphasize safety considerations

- **Plant emergency command center**—Dedicated internal and external communications equipment, key contacts and instructions on how to reach them, health and safety and emergency procedure information for all plant chemicals and anticipated situations, and backup power to the center and the life support equipment/systems for command personnel

- **Process areas**—Batch or continuously operated equipment such as reaction vessels; separation equipment; storage vessels; heat exchangers; pumps, piping, and valves; monitoring and control instrumentation; relief systems; and equipment for handling raw materials, products, and wastestreams

- **Safety equipment in process areas**—Communications systems, safety barriers and markings, safety showers, and personal protective equipment

- **Process control rooms**—Monitoring and control instrumentation, process records and logs, communications systems, process diagrams, operating instructions and procedures, emergency instructions and procedures, log in/log out books, and safety equipment

- **Fire and emergency medical systems**—Vehicles, control equipment, supplies, personnel to respond to plant emergencies, records and logs, communications systems, process diagrams, operating instructions and procedures, and emergency instructions and procedures.

Exercise 3—Safety, Training, and Emergency Response Planning Interviews

In this exercise, members selected from each team will interview Facility X management staff and complete Section 8 - Accidental Release/Incident Investigation, Section 9 - Facility Emergency Preparedness and Planning, Section 10 - Community and Facility Emergency Response Planning, and Section 11 - Public Alert and Notification Procedures. The management staff to be interviewed include the facility manager (who also overviews training), the safety supervisor, and a process engineer (who handles both hazards evaluation and emergency response planning). The interviews will be conducted separately by individual team members in various locations.

Tasks to be accomplished:

1. Perform Facility X management staff interviews.

   Possible interview topics include, but are not limited to:

   - Safety and accident investigation procedures and records
   - Incident investigation findings for the ammonia leak
   - Staff and management training needs and availability
   - Hazards evaluation techniques
   - Emergency response planning

2. Reassemble the team and evaluate the information obtained during the interviews. Reinterview Facility X management staff as needed.

3. Complete Section 8 - Accidental Release/Incident Investigation, Section 9 - Facility Emergency Preparedness and Planning, Section 10 - Community and Facility Emergency Response Planning, and Section 11 - Public Alert and Notification Procedures.

Exercise 4—Audit Report Preparation and Presentation

In this exercise, each audit team will finish preparing a chemical safety audit report for Facility X. They will present their report orally to the rest of the participants. Limited reinterviews of various Facility X personnel will be allowed during this exercise.

Tasks to be accomplished:

1. Complete Section 2 - Summary of Findings/Conclusions, Section 12 - Conclusions, and Section 13 Recommendations.

2. Complete any other section that was not finished earlier.

3. Prepare the team's oral audit report presentation.

CHEMICAL SAFETY AUDIT PROGRAM WORKSHOP

GROUP EXERCISE

CHEMICAL SAFETY AUDIT REPORT

WORKSHEET

1.0 Introduction (includes an introduction to both the chemical safety audit program AND the facility audit)

1.1 Chemical Safety Audit Program:

1.2 Facility X - Pacific Town, Washington, Audit:

2.0 Summary of Findings/Conclusions (includes a BRIEF description of the major findings and conclusions of the audit)

3.0 **Background** (includes general facility and audit information, purpose of the audit and the facility selection process, and audit methodology)

3.1 General Facility and Audit Information

3.2 Purpose of the Audit and Facility Selection Process

3.3 Audit Methodology

4.0 Facility Background Information

(Includes information about the location, size, and general layout of the facility. Also includes information about sensitive populations in the area and a brief description of climatic and topological conditions.)

5.0 Chemical Hazards (includes all chemical hazards that are covered in the scope of the audit; MAY include material safety data sheets)

5.0 Chemical Hazards (continued)

6.0 Process Information (includes storage information, a process description, and process hazards)

6.1 Storage Information

6.2 Process Description

6.3 Process Hazards

7.0 **Chemical Accident Prevention** (includes management activities, process operation and maintenance, hazard evaluation and modeling, release prevention systems, and release mitigation systems)

7.1 Management Activities

7.1 Management Activities (continued)

7.2 Process Operation and Maintenance

7.2 Process Operation and Maintenance (continued)

7.3 Hazard Evaluation and Modeling

7.4 Release Prevention Systems

7.5 Release Mitigation Systems

10.0 Community and Facility Emergency Response Planning Activities

11.0 Public Alert and Notification Procedures

8.0 Accidental Release/Incident Investigation

9.0 Facility Emergency Preparedness and Planning Activities

12.0 Conclusions

12.0 Conclusions (continued)

13.0 Recommendations

13.0 Recommendations (continued)

CHEMICAL SAFETY AUDIT

FACILITY X

PACIFIC TOWN, WASHINGTON

(FEBRUARY 5 - FEBRUARY 8, 1990)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 11

MAY 1990

REPORT DISCLAIMER

The contents of this report reflect information concerning Facility X obtained during a U.S. Environmental Protection Agency Chemical Safety Audit and from records provided by Facility X. The audit was conducted from February 5, 1990, through February 8, 1990, and the observations as presented in this report provide a snapshot of conditions existing at the facility during the audit time frame. They do not represent planned or anticipated changes proposed or on-going at the facility. The recommendations and other report observations contained in this report are not mandatory actions that the facility must implement. In addition, EPA makes no assurances that if implemented, the recommendations and other report observations contained in this report will prevent future chemical accidents, equipment failures, unsafe management practices, or provide protection from a future enforcement action under any applicable law or regulation.

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1.0 INTRODUCTION

1.1 Chemical Safety Audit Program

The Chemical Safety Audit (CSA) program has evolved from efforts of the U.S. Environmental Protection Agency (EPA) under the Chemical Accident Prevention (CAP) program. The primary objectives of the CAP program are to identify the causes of accidental releases of hazardous substances and the means to prevent such releases from occurring, to promote industry initiatives in these areas, and to share activities with the community.

The Chemical Safety Audit program is part of this broad initiative, and has been designed to accomplish the following chemical accident prevention goals:

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

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. CERCLA Sections 104(b) and 104(e), as amended by SARA, provide authorities for entering a facility and accessing information. Specific topics addressed in the audit include:

- Process characteristics:
- Hazard evaluation and release detection techniques;
- Training of operators and emergency response personnel;
- Management structure (corporate and facility);
- Preventive maintenance and inspection programs; and
- Community notification mechanisms and techniques.

1.2 Facility X -- Pacific Town, Washington, Audit

This report contains observations, conclusions, and recommendations from an audit conducted at Facility X, a urea manufacturing plant in Pacific Town, Washington, from February 5 through February 8, 1990. The facility was selected for an audit because of a series of releases of ammonia from the urea production unit, the last one of approximately 500 pounds. This report identifies and characterizes the strengths of specific chemical process safety management program areas to allow the elements that are particularly effective to be recognized. Copies of this report have been provided to the facility's corporate management so that weak and strong program areas may be recognized.

2.0 SUMMARY OF FINDINGS/CONCLUSIONS

Based upon a limited review of the chemical process safety management practices related specifically to the handling of ammonia, the audit team has reached the following conclusions:

- Facility X management is actively sponsoring and providing training for emergency response, maintenance, and operations; has reduced the ammonia operating inventory; and has documented operating and maintenance procedures, checklists, standard safety rules, and procedures for all tasks and operations.

- Facility activities related to preventing ammonia leaks include use of an excess flow valve and earthquake protection measures.

- Facility X has not conducted a hazard evaluation for 5 years due to budget limitations. Corporate policy calls for evaluations to be performed annually. The facility performs maintenance on an "as needed" basis and has extensive records on equipment inspection, testing, and replacement.

- The facility has evaluated an ammonia perimeter monitoring system and elected not to install such a system. However, the facility is currently investigating the use of ammonia monitors at certain potential release points.

- The facility management conducts incident investigations for all deviations from standard conditions and identifies problems in the investigation reports. However, there is no systematic follow-up to correct those problems.

- The facility did not notify the LEPC of its ammonia releases.

- The fire brigade, responsible for handling all emergency situations, does not meet regularly and has not conducted a drill in nearly 15 months. The emergency response plan does not include the names of personnel responsible for relieving employees who leave a job to respond to an emergency.

3.0 BACKGROUND

3.1 General Facility and Audit Information

Facility X is owned by Urea Manufacturing, Inc., the parent company. Facility X operates at the following address:

Facility X
1 Industry St.
Pacific Town, WA 99999

The facility has five buildings and is located north of Interstate Highway 1 and west of County Highway. The facility produces urea in a multi-step process based on the reaction of ammonia with carbon dioxide. The urea is bagged and sold for nitrogenous fertilizer. The audit was conducted from February 5 through February 8, 1990, by a team of Regional representatives from the U.S. Environmental Protection Agency (EPA). EPA was assisted by representatives from the Occupational Safety and Health Administration (OSHA), the State Emergency Response Commission (SERC), and the Local Emergency Planning Committee (LEPC). The names of the team members, their affiliation, their responsibilities in the audit, and their expertise are provided in Appendix A.

3.2 Purpose of the Audit and Facility Selection Process

The purpose of the audit was to examine the facility's chemical process safety management practices associated with ammonia. The facility was selected for an audit based on an analysis of chemical use in the region, referral from the SERC, and the facility's release history. Region 11 identified ammonia and chlorine as the two chemicals used in the highest volume in the region. Based on the facility's release history, the SERC requested through the Regional Office that a chemical safety audit be conducted. There was a series of accidental releases of ammonia occurring over the past year, the last one of approximately 500 pounds.

3.3 Audit Methodology

The audit centered around the process areas related to the use of ammonia in the urea manufacturing process. Because of time and resource constraints, the audit team did not review the production of ammonia from natural gas in the ammonia/carbon dioxide unit. The audit addressed ammonia hazards, chemical accident prevention, process operation and maintenance, hazard evaluation and modeling, release prevention systems, accidental release incident investigation, facility emergency preparedness and planning, and community and facility emergency response planning activities. However, the audit is limited in that it does not attempt to make comparisons or otherwise distinguish between the safety systems used only for urea manufacturing processes and those used for other chemical processes at the facility.

4.0 FACILITY BACKGROUND INFORMATION

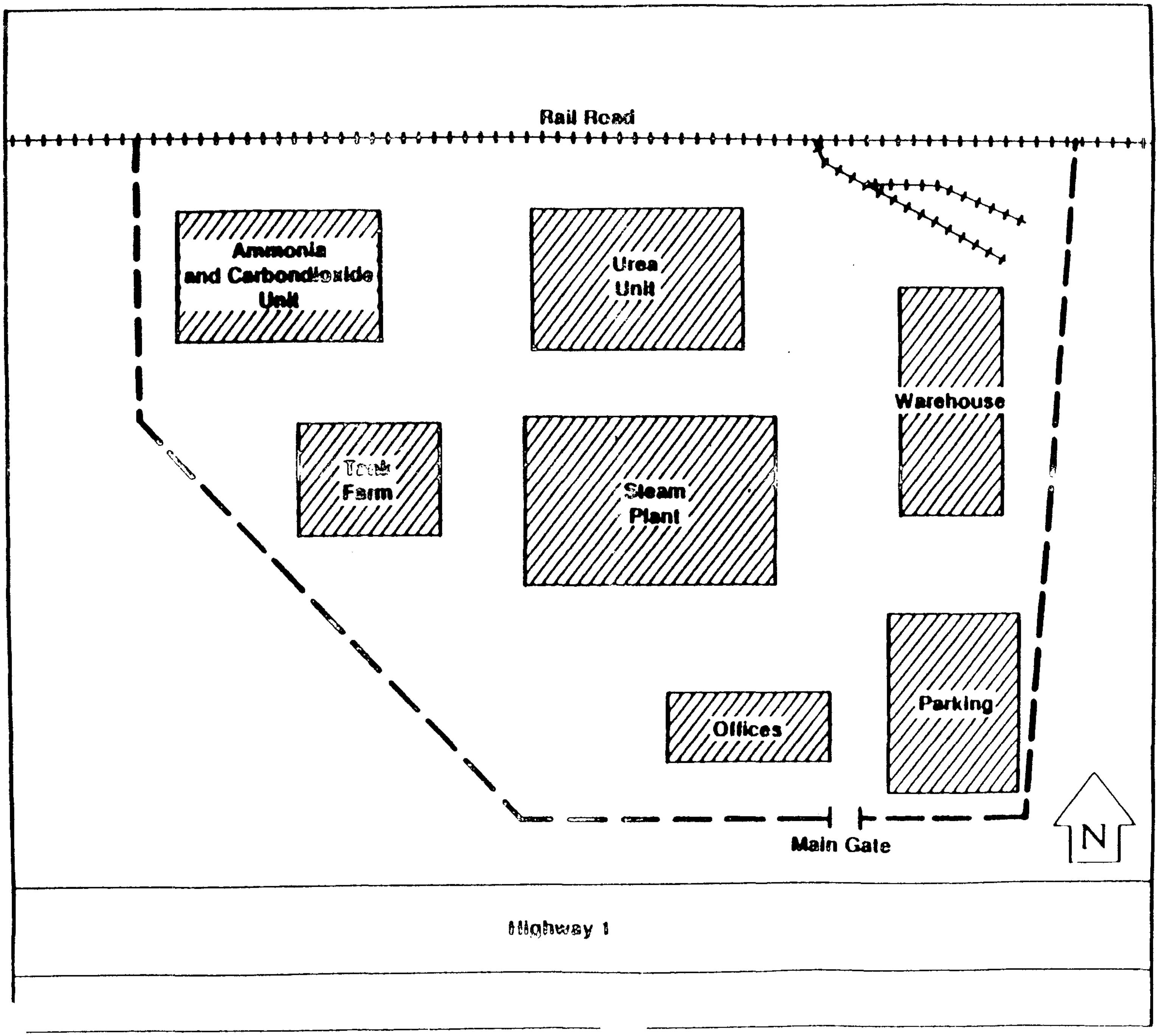
Facility X is located approximately 100 miles west of Seattle on the Pacific coast in an area known as Pacific Town. This facility is located north of Interstate Highway 1 and west of County Highway. Figures 1 and 2 are maps of the area provided to the audit team by the facility. The facility is bounded on the north side by the railroad tracks. There are five buildings on the property; the urea unit, the ammonia and carbon dioxide production unit; the urea storage warehouse, the steam plant, and offices. There is also a tank farm and a parking lot. The facility can be accessed from either the main gate off the Interstate Highway or from the railroad spur. Hazardous and extremely hazardous substances are transported both by highway and rail. The facility is 20 years old and employs 110 persons.

The facility occupies 100 acres in a relatively sparse area approximately 2.5 miles from the nearest community shopping mall. An elementary school is within three miles and a lake, critical to the town's water supply, is within 3.5 miles of the plant. The shopping mall, the school, and the lake are considered by the facility to be sensitive populations and environments for a major ammonia release. Both the County Highway and the Interstate Highway are heavily travelled routes.

Pacific Town experiences the heavy spring rains and high humidity associated with a Northwest Pacific coastal city. Other relevant weather data include an average temperature of 53°F, average relative humidity 73 percent, and mean wind speed of 7.9 miles per hour from east-southeast direction. The facility is situated near a flood plain and minor flooding often occurs in the area during the spring months. The coastal area also is susceptible to earth tremors from nearby earthquake prone zones. In April 1965, before this facility was built, an earthquake with an epicenter in Puget Sound-Tacoma caused extensive building and property damage to the coastal region. In a response to this potential for damage, the facility owners designed and constructed the chemical process buildings with lateral bracing and strong connections to guard against the dangerous horizontal motions which can be caused by an earthquake.

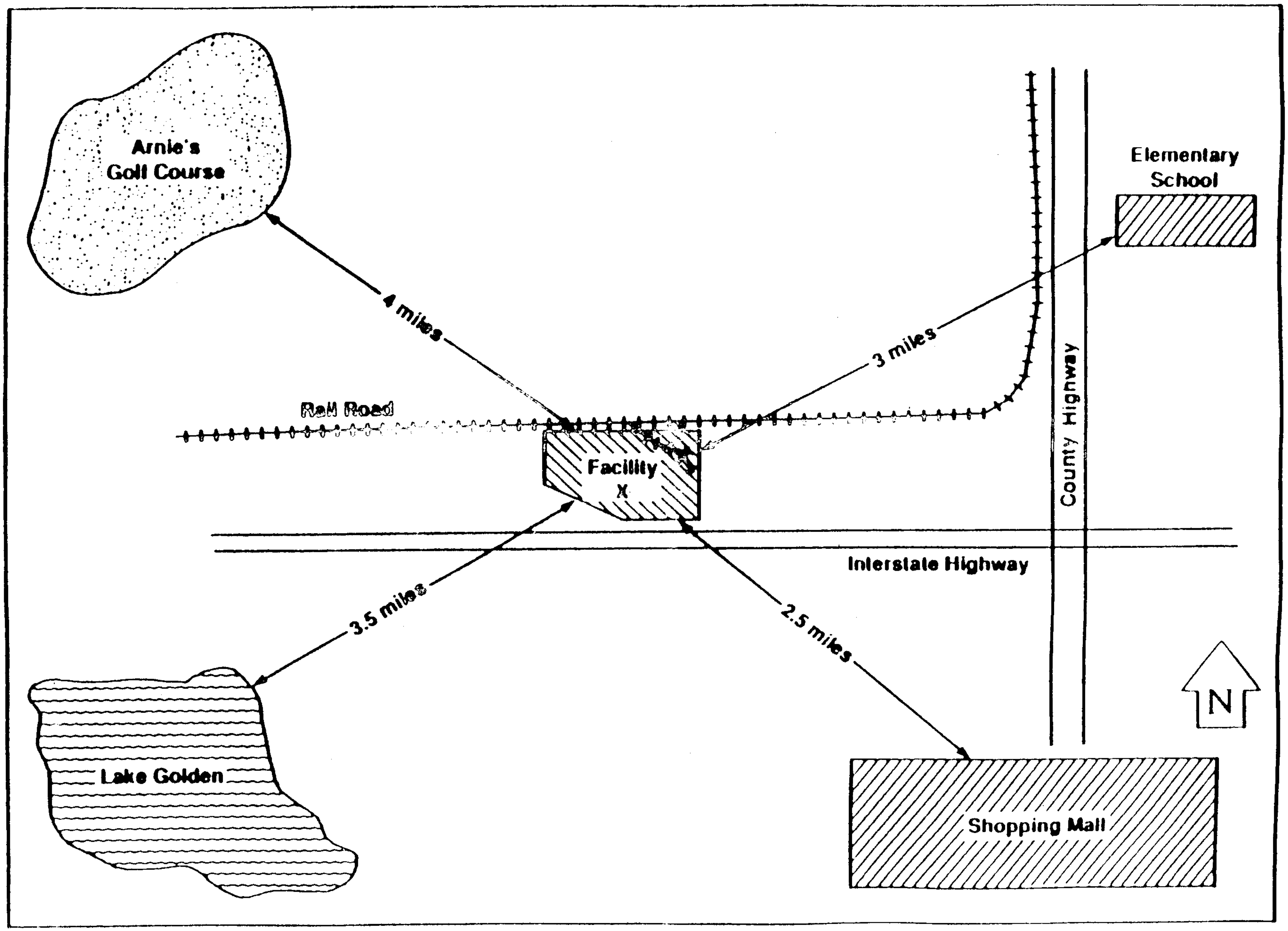
FIGURE 1

Facility X



FIGURE

Communities Around Facility X



The design capacity for the urea plant is 500 tons per day. Currently, it operates at 70 percent capacity. Within the last year, the facility had seven ammonia releases, which were reported to the National Response Center (NRC) and have been documented in internal incident investigation reports.

5.0 CHEMICAL HAZARDS

According to the facility safety supervisor, ammonia, if released accidentally, has the greatest possibility of producing adverse off-site impacts. Ammonia is produced in the ammonia/carbon dioxide unit from natural gas and then pumped into the urea production unit via a surge tank. If allowed to escape to the air, ammonia becomes a colorless toxic gas with an extremely pungent odor. In the worst case scenario anticipated by the facility, a catastrophic failure of the transfer piping would release liquid ammonia which would rapidly evaporate and form a toxic cloud. The gas is nonflammable; however, under certain conditions, it may pose an explosion hazard. The Material Safety Data Sheets (MSDS), which includes the National Institute of Occupational Safety and Health (NIOSH) Immediately Dangerous to Life and Health (IDLH) levels for ammonia is provided in Appendix B. In the ammonia production and urea reactor areas, large bright signs display graphically the hazards of ammonia.

A mini-library of reference materials is kept in each process operations control room. The library includes information on the hazards associated with chemicals used in all of the processes and includes MSDSs, accidental investigation reports, the Merck Index, a folder describing worker rights and responsibilities under OSHA regulations, a document summarizing SARA Title III Community Right-to-Know provisions, and about one dozen books on chemical toxicity, hazard analyses, and basic facility design. Employees are encouraged to visit the mini-library, however, most employees interviewed were not aware of the extent to which these resources existed.

6.0 PROCESS INFORMATION FOR AMMONIA

6.1 Storage and Handling

<u>Storage Systems</u>

There are no dedicated storage systems for hazardous chemicals at Facility X. Ammonia and carbon dioxide production is set at levels sufficient to maintain urea operations.

<u>Shipping and Receiving</u>

Natural gas is delivered to the ammonia\carbon dioxide unit by pipeline from a nearby well in sufficient quantity to maintain a continuous production process. The finished product is transferred to the urea warehouse in the northeast corner of the facility for storage before shipment off-site by railcar.

<u>Material Transfer</u>

Ammonia is produced on-site by Facility X in the ammonia/carbon dioxide production unit building. After the ammonia is generated, purified, and compressed, it is transferred via welded, flangeless pipes to the urea reactor building using electrically grounded equipment to prevent dangerous static electricity sparks. The pump is equipped with a double mechanical seal and seal purge to guard against seal failures and leaks, and an excess flow valve is connected to the transfer piping to prevent accidental releases if a rupture occurs in the piping.

6.2 Process Description

Overview of Processing Steps

Ammonia is reacted with carbon dioxide to produce urea. The two reactants are produced in the ammonia/carbon dioxide unit through a process of steam reforming of natural gas (methane). The natural gas reacts with steam over a catalyst to form carbon dioxide and hydrogen gas. The carbon dioxide is removed and the hydrogen is further reacted with a nitrogen source under elevated temperature and pressure to produce ammonia.

The process flow diagram of the reaction of ammonia and carbon dioxide to produce urea is shown in Figure 3. Ammonia is pumped through the surge tank, heated and vaporized, compressed, and fed to the urea reactor. The reaction with carbon dioxide is exothermic (releases heat) and is controlled at 3515 psia and 365°F. Crude urea leaving the reactor passes through a series of decomposers and pressure reduction valves to separate excess ammonia and carbon dioxide, which are recycled. The urea is purified, crystallized, dried, prilled, and coated to make a final product.

Details of Ammonia Flow in the Urea Production Process

Ammonia from the ammonia/carbon dioxide unit is pumped with high-pressure pumps through welded (non-flanged to prevent leaks) piping and a surge tank. The pumps are equipped with double mechanical seals and purges to prevent seal leaks. If a leak occurs, standard operating procedures call for operators to switch to standby pumps and immediately shut down the leaking pump. The surge tank is designed to provide consistent flow and pressure to the ammonia heater and compressors. The surge tank is equipped with level controls and high-level and -pressure alarms. The tank is also equipped with a relief valve that vents to the atmosphere should pressure get too high.

Ammonia flows next to a gas-fired heater to vaporize the ammonia for feed to compressors and to the reactor. Fuel flow to the heater is interlocked with the ammonia exit temperature control. When exit temperatures get too high for any reason, a high temperature alarm sounds and an interlock cuts off fuel to the heater. The ammonia vapor from the heater is compressed and fed to the reactor. The compressor is equipped with special seals to prohibit leaks and is checked for leaks during operation several times a day.

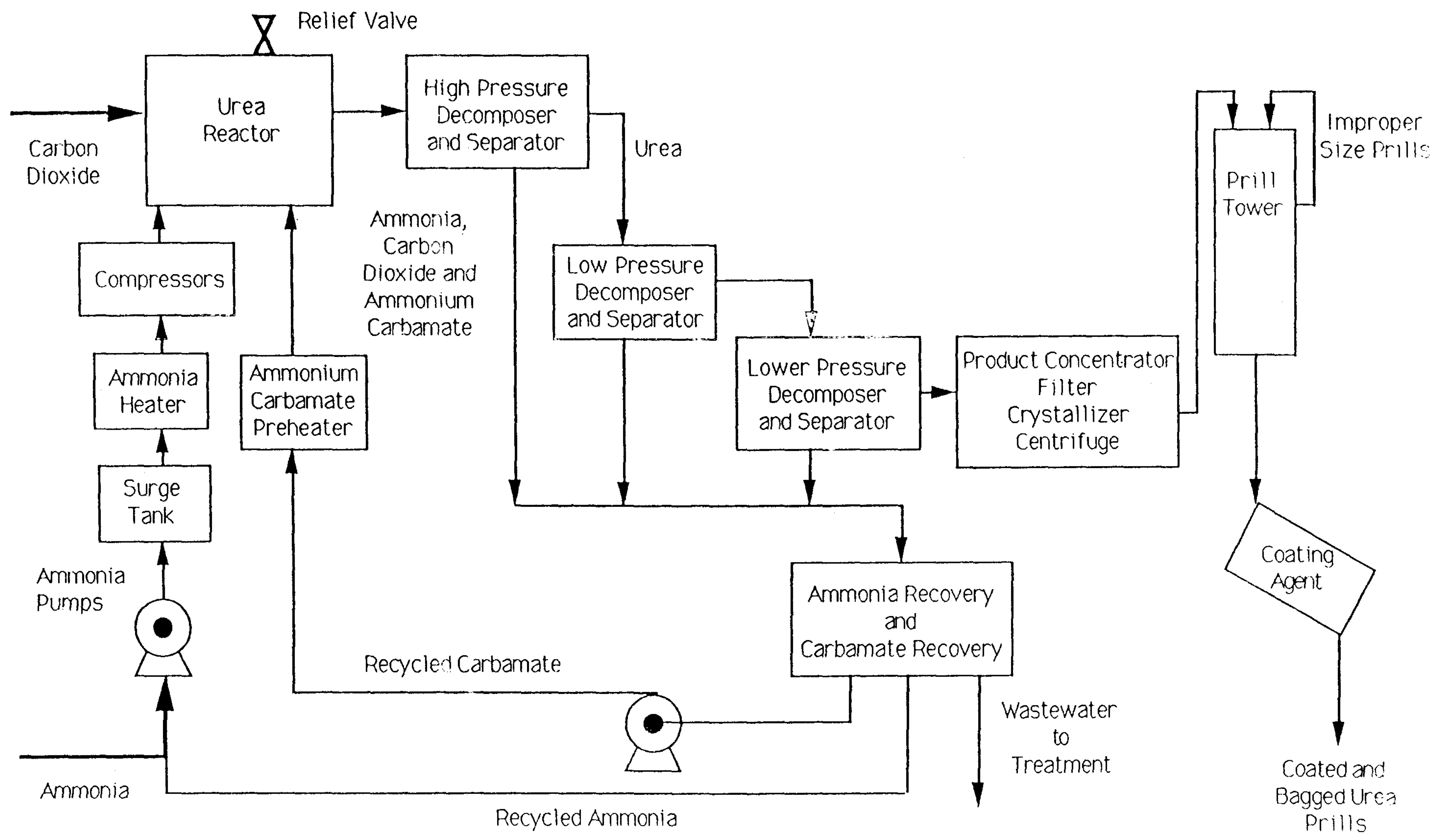
Ammonia, carbon dioxide, and recycled ammonium carbamate react exothermically to form urea. The temperature in the urea reactor can be controlled using the flow of reactants. Pressure is controlled by a pressure control valve on the high pressure decomposer and separator. High reactor pressure causes an alarm to sound and if the pressure reaches a certain level in the reactor, the high pressure relief valve is interlocked open to vent pressure to the atmosphere. All ammonia piping in these systems is welded to prevent flange leaks.

Ammonia Release Detection

According to facility operators, the primary methods for detection of leaks are by visual observation and ammonia odor. Operators make routine patrols to check for leaks. In addition, operators also use portable gas monitors for ammonia detection. The ammonia monitors are used typically after a release has been identified to measure ammonia concentration and to verify the source of the leak. They are not used regularly or stationed around the process. The facility examined the feasibility of purchasing a perimeter monitoring system to measure the presence of several gases including ammonia. The facility decided not to install this system because of the high cost of maintaining it. The facility is investigating installation of a monitor on a few selected locations, such as the compressor, for early detection of leaks. For releases to water, the facility uses continuous nitrogen analyzers to provide quick detection of

Figure 3

FACILITY X
UREA MANUFACTURING PROCESS



ammonia in wastewater. Daily and weekly composite samplers provide analysis of the wastewater to aid in determining the sources of accidental releases.

6.3 Process Hazards

The high temperature and pressure levels in the urea production process present an increased potential for an accidental release.

7.0 CHEMICAL ACCIDENT PREVENTION

7.1 Management Activities

A corporate safety person (a Vice President) is responsible for 22 plants located at various locations within the United States. All environmental regulatory compliance, safety, and health issues are the responsibility of the corporate safety person. At the plant, the safety/loss prevention supervisor has the primary responsibility for safety, health, and the environment. He maintains records of all incident investigations, including accidental releases, and prepares a report for the plant manager within 30 days of each incident that provides the full details of the investigation along with recommendations for improvements of safety. Also, he supervises the employee suggestion program to encourage safety-related suggestions accompanied by monetary rewards. In addition, he maintains records of personnel who have attended training programs at the facility. Training programs include courses on employee safety, emergency response, and equipment operation certification. Facility X is an active participant in the Chemical Manufacturers Association's Community Awareness and Emergency Response (CAER) program and is a member of the Industry Mutual Aid Association, a group of local industries that combine resources to address emergency responses to catastrophic chemical releases. The facility is in regular communication with the corporate safety office and formal meetings are scheduled monthly.

7.2 Process Operation and Maintenance

Management has coordinated the development of training courses on emergency response, maintenance, and operations. Classes include employee safety, chemical hazards, emergency response, certification of operators on equipment, employee retesting, equipment replacement, completing release investigation forms, and an on-the-job buddy system program for new hires.

All operators in charge of the urea process, including the area in which the ammonia release occurred, are given a one-week, four-part training course covering (1) process operation, (2) process hazards, (3) problem solving, and (4) emergency procedures. Part one informs the operator about the reactions in the process and the steps in startup, operation, and shutdown of the urea unit. Operators are provided with routine operations checklists to follow as standard operating procedures. These have been developed and revised by both the process design engineers and the operators. Part two on process hazards is covered in lecture format and part three on problem solving is conducted in a discussion format. Emergency procedures, the final part, is addressed in actual simulation tests on the urea unit. The goal of the course is to familiarize and educate the operators about the process and proper procedures so that supervisory involvement can be minimized. As a result of the latest ammonia accident, the facility management is designing a mini-course for urea operators to review and strengthen their knowledge and skills in problem solving and in following emergency procedures.

Equipment maintenance at this plant is performed on an "as needed" basis. However, the plant conducts regular instrument and equipment inspections and testing, bi-annually during scheduled shutdowns, daily for the nitrogen analyzer, every 1-3 years for relief valves, and every 1.5 years for excess flow devices, transfer hoses, automatic shutdowns, pressure gages, and flow indicators. Records of all equipment inspection, testing, and replacement are kept in the maintenance department office and the process control room. The units in the manufacturing of urea typically operate about 16 hours a day and are left idle overnight. Full shutdown for repair of the units in the urea process occurs every 13 to 16 months.

7.3 Hazard Evaluation and Modeling

Corporate policy requires that cause-consequence analysis or HAZOP evaluations be conducted annually. Facility X has not performed such an evaluation for 5 years because of budget limitations. The facility has worked with the LEPC and used EPA's *Technical Guidance for Hazards Analysis* to perform screening modeling of ammonia releases. This led to inventory reductions as mentioned above. The facility has not conducted any other modeling techniques for evaluation of the consequences of releases other than catastrophic vessel failure.

7.4 Release Prevention Systems

The relief valve on the ammonia surge tank is designed to reduce the potential for a catastrophic release. Also, the urea reactor vessel was recently replaced with a titanium-lined reactor because of its improved protection against corrosion.

7.5 Release Mitigation Systems

Should a release occur at Facility X, the ammonia plant is equipped with a water spray system to help lock down ammonia vapors and reduce their spread. When examined, the spray nozzels were corroded and did not appear to be in good working condition. The spray system was not activated in the last reported release, and the last date of use was unknown.

8.0 ACCIDENTAL RELEASE/INCIDENT INVESTIGATION

Facility X has had seven releases of ammonia over the past year. All were from the urea unit and above the reportable quantity (100 pounds) for ammonia. The last release involved 500 pounds. Three of the releases occurred because of seal failures on pumps, three occurred on the ammonia compressor seals, and one occurred on the pressure relief valve on the urea reactor. The releases ranged from 150 pounds to 500 pounds.

The last reported release occurred from the relief valve on the urea reactor. The urea process was "upset" by fluctuations in the carbon dioxide feed and possible blockage in lines from the reactor. Operators were unable to manually slow down the pressure and feed oscillations in the system. At 10% above normal reactor pressure, the relief valve on the urea reactor lifted, as designed, to protect the integrity of the vessel by relieving pressure to the air. The valve did not reseat, as it should have as pressure reduced, and efforts by the field operator to cause the valve to reseat were unsuccessful. Consequently, the operators shut down the system and emptied the remaining ammonia from the reactor back to the surge tank. All of the efforts to stop the leak, all of the safety precautions, and all of the communication between responders followed documented emergency response procedures.

Upon later inspection, the main seat spring in the valve was found to be corroded, causing the valve to stick open. The facility followed up on the incident by contacting the valve vendor and concluding that the valve failure was "rare and unusual". No documentation exists on why the process became upset, why operators could not stop feed oscillations, and if other causes of high pressure in the urea reactor were identified (e.g., blockage in lines). However, in interviews with various plant personnel, it is unclear if the pressure surges in the reactor are the result of operator error or blockage in the process lines to and from the reactor.

For accidents reported to the NRC, facility policy requires completion of an Accidental Release Report. The report usually is assembled by an operator/maintenance staff with the assistance of the plant safety supervisor. Training is offered to properly teach how to write such a release report. Recommendations from the report are discussed with the plant manager and worthwhile changes are addressed in a follow-up memorandum by the safety supervisor and distributed to the appropriate facility staff. According to the plant safety supervisor, all of the accident reports are annually reviewed to identify common problems and a comprehensive investigation is conducted for each identified problem, such as equipment failure.

9.0 FACILITY EMERGENCY PREPAREDNESS AND PLANNING ACTIVITIES

As an active participant in the local CAER program, emergency response plans at the facility are revised and updated every six months. The plan covers the facility's release response and reporting procedures, emergency equipment provisions, and evacuation routes. In the event of an emergency, Facility X currently has a fire brigade for responding to facility emergencies, including responding to ammonia releases. Equipment for response to ammonia releases includes Level A and B suits and respirators, hand-held ammonia monitors, two-way radios, and an ammonia leak repair tool kit. The fire brigade staff at the facility had received training at the State University Fire Academy to learn better fire fighting, search, and rescue techniques. The fire brigade consists of six operators, all volunteers, and is headed by two shift supervisors who are on duty at the facility during the typical 12 hours daily operations.

Facility X has only one main gate, making fire and evacuation corridors very limited should a full facility evacuation become necessary. Evacuation instructions were posted inside each building. These instructions were clear and corridors were well marked and accessible.

The operators have designated personnel to replace them on a process line if an incident occurs and the fire brigade is activated. However, most operators did not know who their replacement was, and replacements were not listed in the response plan.

The shift supervisors have several other responsibilities besides being the head of the fire brigade. They are responsible primarily for ensuring the proper operation of the process including monitoring operator performance, coordinating operations and maintenance duties, and other management duties. According to some of the fire brigade members, they are so busy with their management tasks, the fire brigade rarely meets to discuss operational issues or conduct drills. During the non-operational hours, the shift supervisors are on-call with a beeper. If an emergency occurs during non-operational hours and the shift supervisor is unavailable, the night watch staff is instructed to call the designated backup staff and the on-call emergency response representative from a nearby chemical facility.

In-plant emergency radios, which are tested every shift, are used to alert all facility staff of an emergency situation. The facility does not maintain a separate, specialized HazMat team, medical personnel, or decontamination equipment.

10.0 COMMUNITY AND FACILITY EMERGENCY RESPONSE PLANNING ACTIVITIES

The management of Facility X has coordinated emergency efforts primarily with the Industry Mutual Aid Association. These include monthly meetings to discuss common hazards, pooling resources, and conducting simulation exercises. In these meetings, facility responsibilities have been designated and formalized in a mutual aid agreement.

As an active participant in the local CAER program, the facility has established a relationship with the LEPC in planning for chemical releases. According to the SERC and LEPC, facility management has provided all information required under Title III. Also, the management has given facility tours to LEPC members and other local emergency response personnel. The facility plans to improve its accidental release notification procedures with the community, including possible use of short-wave radios to notify the LEPC and other local emergency response personnel. Also, the facility plans to hold a joint training program with the Pacific Town hospital to review various types of medical problems such as chemical burns and inhalation.

11.0 PUBLIC ALERT AND NOTIFICATION PROCEDURES

The facility follows CAER's public notification procedures outlined in the "Community-Industry Emergency Notification System". Plant policy is for the operations supervisor to make a decision on notifying the community. Once a decision to notify the local community is made, the procedure calls for the main gate security guard to contact the local fire department by telephone or radio. The exact wording of the notification is stated in the facility's emergency response plan. There has been no testing of those public notification procedures. In addition, the facility has no system for alerting the public of releases.

For each of the seven ammonia releases, the facility notified the NRC and the SERC but did not notify the LEPC. According to facility procedures, release notification to the LEPC is not necessary unless the odor of ammonia is detected by hand-held monitors at the fence line and if the release is above 750 pounds. According to SARA Title III, a release need not result in actual exposure to persons off-site in order to be subject to release reporting requirements.

12.0 CONCLUSIONS

Based upon a review of the chemical process safety management practices related specifically to the handling of ammonia, the audit team has reached the following conclusions:

- The facility has incorporated earthquake protection measures to prevent releases.
- The facility has evaluated perimeter monitoring systems and is in the process of evaluating specific process monitoring for early leak detection in certain high-leak rate areas. Operators are trained in the use of, and do use, portable monitors for locating ammonia leaks.
- Facility X management sponsors and provides training on emergency response, maintenance, and operations.
- The facility's activities related to preventing ammonia leaks include use of an excess flow valve if a failure occurs downstream.
- The facility has documented operating and maintenance procedures, checklists, standard safety rules, and procedures for all tasks and operations.
- Facility X has not conducted a hazard evaluation for 5 years due to budget limitations. Corporate policy calls for evaluations to be performed annually.

- The facility performs maintenance on an "as needed" basis and has extensive records on equipment inspection, testing, and replacement. Several releases involved equipment that failed in service.

- The water spray nozzels for the ammonia release suppression system were corroded and did not appear to be in good working condition.

- The facility identified the cause of the ammonia releases as the failure of the relief valve to reseat after an initial buildup of pressure in the urea reactor, but interviews conducted with plant personnel indicate that the cause of the pressure surges in the reactor have not been clearly identified.

- The facility management conducts incident investigations for all deviations from standard conditions and attempts to follow-up on problems identified in the investigation reports.

- The fire brigade is composed of volunteer operators and two shift supervisors. The fire brigade does not meet regularly and has not conducted a drill in nearly 15 months. The emergency response plan does not include the names of personnel responsible for relieving employees who leave a job to respond to an emergency. Because no documentation existed, it was not clear if these personnel have received the health and safety training required by OSHA for personnel involved in emergency response operations.

- The facility did not notify the LEPC of any of the seven ammonia releases.

13.0 RECOMMENDATIONS

Based upon the audit team's observations and conclusions, audit team recommendations to the management of Facility X include:

- Use of certain monitors and alarms to detect ammonia leaks at locations where leaks frequently occur, such as seals should be thoroughly investigated by the facility.

- The practice of maintenance "as needed" may be contributing to equipment failure and resulting releases. The facility should consider establishing a predictive maintenance and testing program to repair or replace equipment and to prevent failures and releases from critical equipment such as relief valves and seals.

- The facility's budget priorities should be re-examined to allow for hazard evaluations to be completed as required by corporate policy. Investigate use of AIChE Guidelines or use some recently developed resources (like software or contractors) to allow for more timely and cost effective completion of hazard evaluations.

- The facility should clean and test the spray nozzles for the ammonia release suppression system.

- The facility should continue its investigation to determine if blockage or operator error is the cause for pressure surges in the reactor.

- The facility should consider developing formal follow-up procedures, including time schedules, to ensure that incident investigation recommendations are evaluated and implemented, if appropriate.

- The facility should evaluate and adjust the workload demands on the shift supervisors responsible for the fire brigade. They may not have sufficient time to give the attention needed for maintaining an effective, well-tested fire brigade. While there is plenty of commitment on the part of the volunteer operators, emergency response training should be provided, at least to meet the minimum requirements specified by OSHA. In addition, the emergency response plan should contain the names of all backup personnel for these volunteer operators.

- The facility should re-examine their policy and procedures regarding release notification, specifically reporting to local authorities as required under SARA Title III section 304 and to focus on fulfilling the spirit of Title III. The ammonia releases were probably subject to section 304 notification requirements because the releases were above the reportable quantity for ammonia and the releases had the potential to result in exposure to persons off-site. Also, the facility should consider reporting all releases, regardless of quantity, to the LEPC to strengthen and improve relations with the LEPC and the local community.

Appendix A

AUDIT TEAM

Name	Affiliation	Area of Responsibility	Expertise
1. Dale Cooper	U.S. EPA	Management Activities	Environmental Engineer
2. Jane Doe	U.S. EPA	Hazard Evaluation	Chemical Engineer
3. Sam Jones	U.S. EPA/TAT	Process Safety/Maintenance	Chemical Engineer
4. John Davis	U.S. EPA/AARP	Process Safety Systems	Chemical Engineer
5. Mary Miller	OSHA	Employee Training and Safety Procedures	Industrial Hygiene
6. Bob Baker	SERC Representative	Observer/Accident Investigation	Public Policy
7. Jim Taylor	LEPC Representative (Twin Peaks County)	Observer	Chemistry
8. Ray Stone	Pacific Town Fire Dept	Observer	Planner

Appendix B

MSDS SHEET FOR AMMONIA

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)* AMMONIA

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name: Facility X	Emergency Telephone Number: (206) 555-6666
Address *(Number, Street, City, State, and ZIP Code)*: One Industry Street	Telephone Number for Information: (206) 555-5555
Pacific Town, WA 99999	Date Prepared: February 28, 1990
	Signature of Preparer *(optional)*

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Ammonia (NH_3)	TWA 50ppm	TWA 25ppm	IDLH 500ppm	
		STEL 35ppm	TPQ 500lbs	
			RQ 100lbs	

Section III — Physical/Chemical Characteristics

Boiling Point	-33° C	Specific Gravity (H_2O = 1)	Liquid: 0.68 @ -33° C
Vapor Pressure (mm Hg.)	400 @ -45°C	Melting Point	-78° C
Vapor Density (AIR = 1)	0.6	Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water: 31g / 100g @ 25° C

Appearance and Odor: Colorless gas or liquid; sharp, cloying, repellant

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
		16%	25%

Extinguishing Media: Small fires: dry chemical or carbon dioxide. Large fires: water spray, fog, or foam

Special Fire Fighting Procedures: Wear positive pressure breathing apparatus and full protective cloth

Unusual Fire and Explosion Hazards: Mixing of ammonia with several chemicals can cause severe fire hazards and/or explosions. Ammonia in container may explode in heat of fire

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid Mixing with other chemicals and water
	Stable Yes		

Incompatibility (*Materials to Avoid*)
Strong oxidizers, calcium, hypochlorite bleaches, gold, mercury, silver, and halogens

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur Yes		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Yes Skin? Yes Ingestion? Yes

Health Hazards (*Acute and Chronic*)

Eye and respiratory tract irritant

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions Generally Aggravated by Exposure

Emergency and First Aid Procedures

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Ventilate area of spill or leak to disperse gas. If in gaseous form stop flow of gas. If source of leak is a cylinder and cannot be stopped, remove to open air and repair leak or allow cylinder to empty. If in liquid form allow to vaporize.

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions
In case of release or spill, keep unneccessary people away, isolate hazard are and deny entry. Stay upwind out of low area. Evacuate area endangered by gas.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)
Positive pressure, pressure-demand, full facepiece SCBA or pressure-demand supplied air

Ventilation	Local Exhaust	Special
	Mechanical (*General*)	Other

Protective Gloves	Eye Protection

Other Protective Clothing or Equipment
respirator with escape SCBA and a fully-encapsulating, chemical resistant suit.

Work/Hygienic Practices

☆U.S. Government Printing Office: 1987—181-804/84342

Text Summary

2783008538

SITE DATA INFORMATION:
Location: LONG BEACH, CALIFORNIA
Building Air Exchanges Per Hour: 0.52 (Sheltered single storied)
Date & Time: Fixed at March 17, 1992 & 1200 hours

CHEMICAL INFORMATION:
Chemical Name: SULFUR DIOXIDE
Molecular Weight: 64.07 kg/kmol
TLV-TWA: 2.00 ppm
IDLH: 100.00 ppm
Footprint Level of Concern: 0.2 ppm
Boiling Point: 13.96° Fahrenheit
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC INFORMATION: (MANUAL INPUT OF DATA)
Wind: 2.5 meters/sec from N
No Inversion Height
Stability Class: B
Air Temperature: 85.° Fahrenheit
Relative Humidity: 5%
Ground Roughness: Urban or forest
Cloud Cover: 1 tenths

SOURCE STRENGTH INFORMATION:
Direct Source: 1 grams/sec
Source Height: 0
Release Duration: ALOHA limited the duration to 1 hour
Release Rate: 0.132 pounds/min
Total Amount Released: 7.94 pounds
Note: This chemical may flash boil and/or result in two phase flow.

FOOTPRINT INFORMATION:
Model Run: Heavy Gas
User specified LOC: 0.2 ppm
Max Threat Zone for LOC: 188 yards
Max Threat Zone for IDLH: 11 yards
For more detailed information check the Time Dependent Conc/Dose information at specific locations.

TIME DEPENDENT INFORMATION:
Concentration/Dose Estimates at the point:
Downwind: 16 yards
Off Centerline: 0 yards
Max Concentration:
Outdoor: 24.1 ppm
Indoor: 9.67 ppm
Max Dose:
Outdoor: 1,420 (ppm,min)
Indoor: 310 (ppm,min)
Note: Indoor graphs are shown with a dotted line.

FootPrint Window

2783008536

```
Chemical Name: SULFUR DIOXIDE
Model Run: Heavy Gas
Wind: 2.5  meters/sec from N


FOOTPRINT INFORMATION:
   Model Run: Heavy Gas
   User specified LOC: 0.2 ppm
   Max Threat Zone for LOC: 188 yards
   Max Threat Zone for IDLH: 11 yards
   For more detailed information check the Time Dependent
     Conc/Dose information at specific locations.
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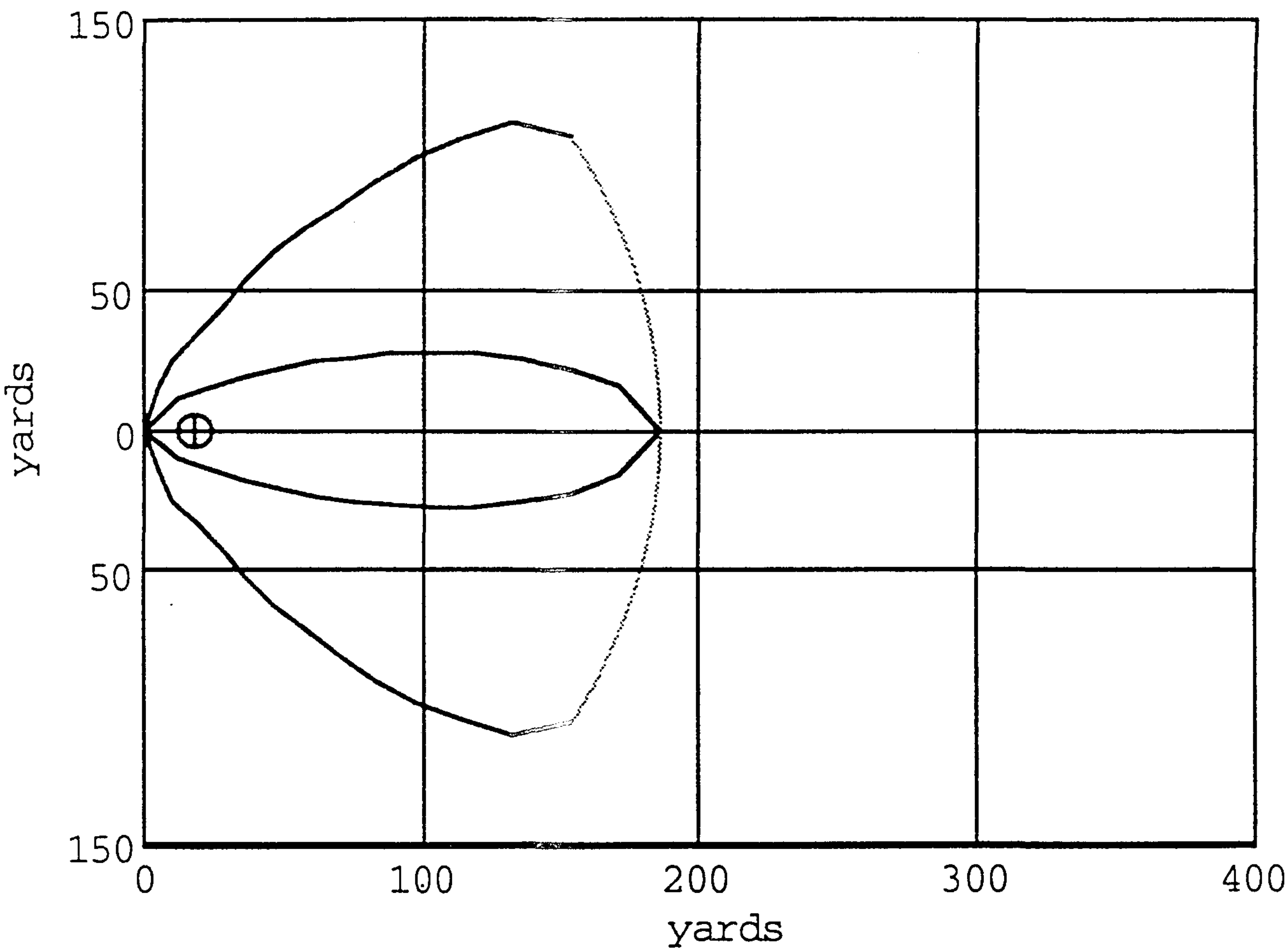

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