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CURRENT PRACTICES IN HANDLING HAZARDOUS CHEMICALS IN THE CHEMICAL INDUSTRY

A Report for the MIC Task Force

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EXECUTIVE SUMMARY

- This report describes the current safety practices in the chemical manufacturing industry and the framework of federal, state, and local laws that guide those practices, particularly those intended to prevent sudden, catastrophic releases of hazardous substances. The information in the report is based primarily on discussions with two large, multi-facility chemical companies and two small, single-plant firms, supplemented by interviews with two states and representatives of the insurance industry.

- In general, the external requirements that control and monitor the safety practices of the chemical industry are very limited in scope and in depth. Requirements intended to prevent releases of hazardous materials, primarily under EPA or state air permitting programs, focus on controlling continuous or routine emissions from normal operations, rather than on unintended releases. Regulations intended to minimize the effects of an accident through emergency response measures focus on in-plant effects and worker protection, and generally do not address releases that affect the surrounding community.

- One exception is the regulatory framework governing the transportation of hazardous materials. DOT regulations are fairly comprehensive, particularly for acutely hazardous materials, prescribing packaging and labeling for hazardous materials in transport, and design standards for certain transport vehicles.

- No external agency or entity now conducts a comprehensive evaluation of the chemical process itself to determine whether it is designed and operated properly, and whether back-up systems and emergency procedures are adequate.

- Nevertheless, the chemical companies take extensive precautions to prevent accidents and releases that go far beyond what is required by law. The companies' principal motivations for these voluntary actions are:

  - <u>Concern for corporate profitability and employee morale</u>: A well-run plant with few accidents is more profitable, and an employee with confidence in the safety of his work environment is more productive.

  - <u>Concern for financial loss due to property damages, loss of use, or liability claims</u>: Most companies self-insure for a large portion of their potential costs, which translates to direct financial loss for damages when accidents occur. Costs due to liability for damages from product use, worker injuries, and environmental impairment, or damage occurring outside the plant, can be significant.

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- Concern for insurability and insurance costs: A company's ability to obtain insurance against risks and the size of the premiums depends on its accident and loss record.

o The large companies devote considerable resources to hazard evaluation, process design and safety features, employee training, and internal inspections to ensure equipment is in proper working condition and operating procedures are followed. The companies conduct extensive analyses to ensure a new process will operate safely, hypothesizing possible events and equipment failures, and building in back-up systems, response mechanisms, and procedures to reduce the possibility of accidents and resulting damages when accidents occur.

o By contrast, the small companies have far fewer resources available for safety assessments. They generally do not have formal safety review and evaluation systems in place like those used by the larger firms, and tend to rely on suppliers and published sources of information for hazard data. They depend more on local authorities for fire-fighting and other emergency response services, while large plants, for the most part, are self-sufficient.

o However, neither of the small companies interviewed handles extremely hazardous materials. They know the limits of their equipment and expertise and will not produce or use chemicals with hazards they are not equipped to handle.

o Moreover, the small companies generally use and produce relatively small quantities of chemicals. They sell almost exclusively to large chemical firms, who use the small chemical manufacturers when they need only a limited amount of a specific chemical that is not economically feasible for them to produce.

o The small firms use batch processes and specialize in the manufacture of a limited range of related chemicals. They know the handling characteristics and potential hazards of these chemicals well.

o Both of the large firms have undertaken intensive self-evaluations in response to the catastrophe at Bhopal. They are identifying the chemicals they use that have the potential for serious effects if a release were to occur and inspecting their plants and procedures to ensure they are adequate. In addition, one of the small firms has joined with several of its neighboring plants to work with local authorities to develop emergency procedures. They also intend to evaluate the safety practices of each of the participating firms.

Current Practices in Handling Hazardous Chemicals in the Chemical Industry

INTRODUCTION

Chemical manufacturers operate within a framework of federal, state and local laws that guide many of their safety practices. A number of incentives - concern for insurability, avoidance of liability, and worker safety and morale - encourage companies to go beyond the minimum required by law. This report examines current safety practices in the chemical industry that affect the chance of an accidental, catastrophic release of a hazardous chemical to the environment or the potential impact of such a release. It also discusses the internal and external controls intended to ensure that companies behave responsibly in handling dangerous chemicals.

Sources of Information

The report is based primarily on interviews with officials of four chemical manufacturing companies: two large companies with many domestic and overseas plant sites and two small, owner-operated companies with single plants. The large companies are among in the top five in chemical production, with annual sales of more than $5 billion. One company manufactures basic chemicals only, while the other produces both end-products and basic chemicals. Both have large safety departments in corporate headquarters that design new processes and safety systems and oversee safety practices in individual plants.

Each of the small companies that were interviewed have annual sales of $4 to $10 million, or a hundred-fold less than the major companies. Both companies produce specialty chemical intermediates, usually in small quantities (one company manufactures a maximum of 40,000 pounds per chemical product, the other 100,000 pounds, and both might produce as little as one pound of a given product). The companies use batch processing to manufacture a variety of related chemicals: one company specializes in variations of long chain, saturated alkanes, brominated alkanes, and alkenyl succinic anhydrides; the other in intermediates for pharmaceutical chemicals. In general, the feedstocks and products handled by these two firms did not have extremely hazardous properties; flammability and chronic effects, like potential carcinogenicity, are the properties of greatest concern.

Small chemical producers occupy a valuable niche in the chemical manufacturing field: they specialize in certain classes of chemical products and produce volumes too small to be economically feasible for large companies with their dedicated equipment and large bureaucracies. Both small companies interviewed sell almost exclusively to large chemical manufacturers.

In addition to consulting with chemical manufacturers, we talked to several state agencies in two states to supplement information provided by the companies on state and local regulations. We also met with a representative of the insurance industry to discuss that industry's influence on safety practices.

Control Points in the Manufacture and Marketing of Chemicals

This discussion covers eight areas where external controls and internal decisions about safety systems and precautions affect the liklihood of catastrophic release similar to that which occurred in Bhopal. These are:

- Chemical hazard evaluation
- Siting of a new chemical plant or process
- Process and equipment design
- Construction
- Process operations and maintenance
- Emergency response
- Product marketing
- Transportation

In each area, we discuss federal, state, and local laws that control or influence company decisions, the role of other outside forces, and the companies practices and motivations.

The discussion of federal laws that regulate chemical companies primarily covers laws and authorities mentioned by industry representatives in our interviews, and therefore is not a comprehensive or exhaustive list of all the federal laws that might influence company behavior. A more complete analysis of federal statutes and regulations is covered in other work conducted for the Task Force.

Information presented here on controls at the state and local level is derived from discussions with two states and with the industry representatives. While we have tried to reflect the situation in states and localities generally, some states and local authorities may have somewhat different laws and concerns than those described here.

Impact of Insurance on Safety Behavior

Concern for liability and insurability influence company behavior in all of the areas listed above. All firms insure to some extent against property damage, worker compensation claims, and product liability. Many carry other types of liability insurance as well.

The current situation in insurance creates strong incentives for companies to take actions to reduce the risk of accidents. First, premium costs are based on a company's past safety record. A firm can significantly reduce insurance costs by lowering its accident rate. Moreover, a company with an unusually bad accident history faces loss of insurance coverage.

Second, many companies self-insure for a portion of their potential damage or liability costs, building predictable losses into their operating costs. This practice of self-insurance thus translates into direct financial loss to the company if accidents occur. A large company may self-insure for up to the first $50 million in damages, carrying only catastrophic insurance coverage for claims that exceed that amount.

Third, insurers influence a company's safety practices directly by inspecting a plant when a policy is first issued and often requiring certain safety practices as a condition of the policy.

Fourth, liability insurance for sudden or accidental releases outside the workplace boundaries, called "environmental impairment liability," is becoming increasingly difficult to obtain. A company must seek to minimize this kind of risk to prevent bearing the full amount of any financial loss if it cannot obtain insurance.

CHEMICAL HAZARD EVALUATION

In order to design and operate a safe process, the company must first know the hazards of the chemicals it uses and produces. This may involve testing new chemical products in the research phase with an eye toward future product liability, or evaluating the hazards of feedstocks and intermediates to assess whether a product can be made safely.

Federal Controls

- Under the Toxic Substances Control Act (TSCA) EPA reviews available data on new chemicals to ensure they will not present unreasonable risks. Although it focuses on the properties of proposed new chemicals, EPA can also assess the hazards of the production process. It can impose a variety of controls on the manufacturer, ranging from testing and worker safety precautions, to a total ban on production.

- Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), EPA reviews and registers pesticide products, weighing the risks of each product against its efficacy. EPA evaluates only the product and its use and does not have authority to consider the hazards associated with its manufacture.

- The Occupational Safety and Health Administration (OSHA) has set permissible exposure limits (PEL) in the workplace for some 400 chemicals and developed comprehensive standards for an additional 22. To use or produce these chemicals, a manufacturer must design a process that ensures levels in the workplace will be below the PEL.

- OSHA has also recently promulgated a hazard communication standard, or "right to know" regulation, effective in November 1985. It requires manufacturers to develop hazard information on all their products and transmit that information through labels and material safety data sheets (MSDS) to their workers and industrial customers.

- The Department of Transportation (DOT), under the Hazardous Materials Transportation Act, places labeling, packaging and other requirements on chemicals with certain hazard properties while in transport. To comply with DOT regulations, a manufacturer must know if his chemicals fall into one of DOT's hazard classes.

State Controls

- Few if any states have laws that specifically require companies to test their chemicals for hazards, and most states do not know the chemicals in use in their states.

- However, both states we interviewed recently passed "right to know" laws, similar but broader than OSHA's, that require all employers to transmit chemical identity and hazard information to their users and to the state. In one state, the law applied to all chemical products; in the other, it applied to a list of over 800 chemicals developed by the state. Laws like these indirectly encourage testing to identify hazards, although the two states did not know whether more testing was actually taking place.

- The question of preemption of similar state laws by the new OSHA hazard communication law has not yet been settled.

Large Company Practices

- Testing to evaluate the hazards of a proposed chemical and the intermediates involved in its production begins at the research phase and continues throughout process development. Nearly all chemicals used or made in the process are tested to determine their physical properties, such as flammability and corrosivity, and acute toxicity. A series of short-term tests for chronic effects like mutagencity and teratogencity are also run on most organic chemicals. The results of these tests determine what the controls and safety procedures used in the production process will be.

- The company may decide not to proceed with the development of a new product if the results of the hazard evaluation indicate that the process may create serious, uncontrollable hazards. The company will first seek a substitute chemical or a safer synthesis route. If no workable alternative is found, product development may stop.

  - One company decided not to produce a pesticide that it found was capable of producing irreversible eye damage. The company believed there was no way of guaranteeing that applicators in the field would be protected.

- New hazard information on a chemical already in production has also affected company decisions.

  - A solvent used in making a pigment was found to be a mild carcinogen. Although carefully handled, it was produced in very large quantities. The company believed the solvent presented an unacceptable risk to its employees and stopped production of the pigment.

Small Company Practices

- While the large companies conduct extensive hazard testing on the chemicals they use and produce, the small companies primarily use hazard data developed by others. They rely on literature searches of scientific journals or public data bases to assess the hazards of unfamiliar chemicals. They also obtain information from chemical suppliers, although there is considerable variation in the quality and completeness of the information provided.

- The small companies treat "new" chemicals, those subject to EPA review under TSCA, quite differently from existing ones, even those that are new to the company.

  - One company hires outside labs to test new chemicals for their acute hazard properties and frequently for chronic hazards using an Ames test. Although such testing is not required, the company prefers to have EPA review real hazard data rather than have to rely on an assessment of structural analogs.

  - The company usually decides not to manufacture a new chemical if tests results indicate potential hazards. It will not manufacture a chemical, for example, if the Ames test is positive. It makes this choice less from concern about the product than concern about costs and "hassles" associated with the premanufacture notification (PMN) process at EPA.

  - Whether or not a chemical is "new" plays an important part in the other company's decision to accept an order. If the chemical will be subject to a PMN, the company will negotiate with its customer, generally a large company, concerning submitting the notice and developing hazard data.

SITING

The physical location of the plant facility is an important factor in determining the amount of damage or harm that results if an environmental release occurs. The more remote the location, the less the impact will be. However, the primary factors affecting a company's siting decisions are financial and administrative, rather than environmental.

Federal Controls

- The most significant external constraints on siting are those imposed by the air permitting program under the federal Clean Air Act and administered by EPA or the states.

  - Prevention of Significant Deterioration (PSD) requirements are the most constraining because of the delays involved. No construction can begin until a pre-construction permit is issued, which requires a year of background ambient data for site, extensive modelling, and lengthy review time by the permitting agency. Because EPA and the states share review responsibilities, additional time may pass as they resolve differences.

  - State Implementation Plan (SIP) requirements in non-attainment areas tend to be less constraining. A company wanting to locate in a given area must find an existing source with similar emissions for an "emissions trade." Delays can occur if a state or local agency asks for identification of the specific components of any volatile organic compounds (VOCs) to be emitted and insists that those traded be of comparable toxicity and volatility.

State Controls

- Generally, most states can only exercise control over siting of new facilities through their air or water permitting programs, although there are exceptions. For example, New York requires a state-level environmental impact statement for every new facility or significant modification to an existing facility.

Local controls

- Most local authorities have final control of facility siting through land use planning and zoning laws. This can be a significant constraint in some states and localities, but most local governments welcome new industrial facilities and the jobs they bring, and willingly modify zoning plans to accommodate proposed new facilities.

- In general, zoning is a problem only for new facilities; it is less of an issue if an existing facility is expanded or modified. One state pointed out that a company can build a new facility in an area already zoned for industrial development without applying to the local zoning board. In that state's older cities, heavy industry is often located adjacent to residential areas.

- All communities have load limits on feeder roads, and some have restricted routes for hazardous loads. These controls generally have not been a significant constraint for the reason cited above: a locality will normally take the necessary measures to accommodate a proposed new facility.

Large Company Practices

- The large chemical companies, with many plant sites to choose from, usually adapt existing facilities or build new plants on existing sites to accommodate new chemical processes. Decisions on location of the new process are based not on concerns about the proximity to population, but on economic and managerial considerations.

- One company said it rarely opens a new plant site anymore, but modifies its operations at an existing site. Decisions about location are made early in the development process and are based on factors like the adaptability of existing equipment, proximity to raw materials and markets, and availability of qualified personnel.

- The other firm had specific guidelines for siting new processes that take similar factors into account.

  - Use of existing facilities. The company prefers to adapt an existing plant if there is one that can accommodate the new process.

  - Transportation cost. The process is located to minimize transportation costs of raw materials and finished products. Proximity to consumers is usually weighed more heavily because transportation costs are for finished products are usually more than those for raw materials.

  - Total size, complexity of the facility. The company believes a facility can be too large and complex to be manageable. When considering an expansion, it assesses whether the expanded facility will be within the ability of a plant manager to oversee it. The company noted, however, that other chemical companies prefer to locate all their facilities in one place.

  - Availability of a qualified labor pool is a consideration in siting a new facility. The company takes into account amenities in the community that will make it attractive to employees, such as good local schools and educational institutions for professional training.

  - The potential impact on ground water is a new, major concern in siting new facilities. In the future, the hydrogeology of a proposed new site will be an important factor in site selection.

- In the past two decades, this company has made it a policy to acquire an excess of land beyond what is needed for the plant itself. If a facility requires tens of acres, the company acquires thousands of acres. It creates this sizeable buffer zone primarily for aesthetic reasons, a response to recent local concerns about the visual impact of industrial facilities.

- Beyond its policy of acquiring excess land, the company does not deliberately site plants away from residential areas, because it recognizes that no site will remain remote; new residential areas will inevitably be built to accommodate employees who want to live nearby. It believes that its safety measures to protect plant employees, who would be affected first if an accident occurred, are adequate to protect the surrounding population.

Small Company Practices

- Siting a new facility is not a concern of the small companies we interviewed, who operate single plants and have no plans to expand. They did mention, however, that adequate utilities and access to a nearby hazardous waste disposal facility are important considerations. Transportation costs for feedstocks or products are less important to the small firms, which deal with relatively small quantities.

PROCESS AND EQUIPMENT DESIGN

Design of the chemical process involves choosing pathways and operating parameters, and selecting the appropriate equipment to produce the product in the most efficient and safest way possible. At this point, a company will usually have obtained chemical hazard information that determines what safety features and backup systems are needed to ensure a safe operation.

Federal Controls

- EPA influences process and equipment design, directly or indirectly, through its pollution control programs in air, water, and hazardous waste. Requirements to control air pollution probably have the greatest impact on design features related to environmental releases, but, even in this program, the focus is on continuous, anticipated releases, not on accident prevention.

  - Limits on air emissions affects the design of scrubbers and of valves and seals to minimize fugitive emissions.

  - The increasing costs of hazardous waste management under RCRA requirements provide an incentive for companies to design or modify their processes to reduce the volume of wastes generated, and to recover and reuse more of the wastes that are generated.

  - A company may need to install special equipment or modify its process to comply with permit limitations on its wastewater discharges.

- Two types of OSHA requirements affect process design:

  - Permissible exposure limits and maximum allowable concentrations for certain chemicals, which may require some processes to be enclosed;

- Standards for potential safety hazards, such as those covering the handling of flammable and combustible liquids; reactive and unstable liquids; and the design, installation and operation of storage tanks.

State Controls

o The state is likely to have the greatest impact on process design through its air permitting program for proposed facilities. Many states now require facilities to meet EPA-developed draft RACT (Reasonably Available Control Technology) guidelines for volatile organic compounds. One state requires new facilities to meet Best Available Control Technology standards, which go beyond federal requirements. In making permitting decisions, it reviews the engineering design and proposed operating procedures prior to construction. It also has information on all chemicals used in the plant, as well those that may present emissions problems. It does not, however, require existing facilities to meet these standards unless the facility has a very serious pollution problem.

o Virtually every state requires that pressure vessels meet ASME (American Society of Mechanical Engineers) standards. There are separate standards for fired pressure vessels, or boilers, and unfired pressure vessels, or pressurized storage tanks. The state usually inspects fired pressure vessels when first installed, with periodic checks thereafter to make sure all such equipment has the ASME seal on it. Unfired vessels are generally inspected only at the time of installation.

Local Controls

o Although local building codes apply to chemical plants, they are intended mainly for homes, apartment buildings, and commercial buildings. There is little in these codes applicable to chemical plants design, although there are some exceptions. For example, there may be local requirements that internal electrical lines be placed in conduits.

o One company said that local authorities rarely inspect its chemical plants to assess compliance with the building code. Instead, the company "certifies" that the design complies with the applicable portions of the code. If an inspection is conducted, it is done only when the plant first goes into operation.

o The National Fire Protection Association (NFPA) has developed a model code addressing the storage and handling of flammable materials. The NFPA Code addresses such matters as:

- the amount of certain materials that may be stored in a single container, including fixed tanks and drums.
- the minimum spacing between such containers.
- required fire protection equipment at a facility, given the quantity and flammability of the materials present.

- Approximately one-third of the 14,000 local code-setting authorities (i.e., counties, townships, cities, etc.) require facilities to follow the NFPA code. Some facilities are inspected by the fire marshal for conformity with the code; others are not, especially those that are self-sufficient in terms of fire protection.

- In one state, a plant is required to have a license to store flammable materials, issued by the local fire marshall. However, a license, once issued, is transferable, and the practices of a new license holder are not subject to review.

Industry or Engineering Standards

- There are many voluntary industry standards developed by committees of industry experts that cover a variety of aspects of plant engineering, design, and maintenance. They include, for example, the construction and maintenance of electrical equipment, piping, valves, and storage vessels and standards specific to the petroleum industry. There are also standards for handling and transport of chlorine. (See attachment for a list of industry standards.)

- These standards are revised periodically. For example, the National Electrical Manufacturers Association standards are revised every 3 years, with opportunity for review and comment from the entire Association membership, a process that takes two years to complete.

- Most companies follow these standards unless there is a compelling reason to modify them. Some standards, like the NFPA, are incorporated into state or local law. Even where compliance is not required, the standards are widely used to ensure safe practices and satisfy insurers.

Large Company Practices

- Design and evaluation of a new process begins in the research stage, where the chemical process and operating parameters are laid out, and moves to engineering analysis, which designs the equipment and process flow to produce the chemical. At a very early stage, safety assessments come into play, which look at the need for special equipment or backup systems to ensure the system can be monitored and managed safely. One company uses a project team to develop a new process, which includes safety specialists to ensure safety concerns receive full attention.

- For each new process or significant modification, the companies conduct extensive analyses identifying possible events that could lead to accidents, informally called "what if" analysis. The analysis identifies the consequences and possible responses to such events to ensure they will be resolved safely.

- One company conducts a formalized, quantititive fault-tree analysis, called "Process Hazard Assessment," that may take 6 months to complete. It uses a strict operational definition of "acceptable risk," defined as one serious accident over a period of 300 to 600 times the projected life of the facility. Thus, if a process is expected to be in operation 40 years, it will take measures to reduce the risk of a serious accident to once every 12,000 to 24,000 years. Even mining process modifications are subjected to an explicit hazard analysis, though a less quantitative one.

- The companies rely heavily on fail-safe designs for each process component, which means if the component fails, it will fail in a way that does not impair safety. For example, valves are designed to remain open or closed, whichever is the safer condition, if the process that activates them shuts down.

- The companies rely heavily on "redundancy," or backup systems, to reduce risks. For example, tanks where pressure-creating reactions are possible may be designed with two independent pressure relief valves as well as a separate rupture disk, which ruptures at high pressure, to guard against multiple failures in the valves. One company that uses a computer system to monitor and control the chemical reaction has a backup computer in case the main system goes down.

- Companies have developed their own internal standards for certain items. For example,

  - One company developed its own design for safety showers for any new safety showers installed in its facilities.

  - A company decided the standard design for tank cars for three chemicals (metallic sodium, hydrogen cyanide, and tetraethyl lead) did not provide what it considered to be an adequate degree of protection. It developed more stringent, specialized tank car designs for each substance, now in use for 15-20 years. Although some of these cars have been involved in serious rail accidents, there has never been a loss of material from any of the cars. One tank car containing sodium was involved an accident that knocked it off a barge to the bottom of a river. It was hoisted up two days later without any sodium being released. Metallic sodium reacts so violently with water that an violent explosion would have occurred had the tank car ruptured.

Small Company Practices

- Process design for the small companies involves a determination of whether a new chemical requested by a customer can be safely produced with existing equipment. Rather than designing an entirely new process and new equipment, they limit their production to related chemicals that are appropriate for their equipment and expertise.

- One of the factors important in that determination is the hazards of the chemicals used and produced in the process. If the process involves acutely hazardous chemicals that the company is not equipped to handle, it will generally not accept the order. In seven instances last year, one company decided the process was too hazardous for its operations and decided not to produce the chemical.

CONSTRUCTION

After the process is designed, the plant must be constructed in conformance with the approved design.

Federal Controls

- There is no federal oversight of construction other than to ensure the safety of the construction workers. No inspections are conducted to ensure the facility is properly constructed.

State Controls

- While states do not have specific construction standards, some states do conduct inspections of newly-built facilities under air permitting programs.

Local Controls

- Some local jurisdictions inspect new facilities to assess whether they meet building codes. As discussed previously, the scope of the inspection is limited.

Insurer Controls

- An insurance company often inspects a facility when it first insures a plant or new process against property damage, except in cases where the size of the premium or coverage is not large enough to justify the cost of inspection. Insurers may also be consulted when a plant is being designed. The inspector looks at all aspects of equipment and design, assessing the chemical hazards and provisions made to prevent or mitigate risks, although the effectiveness of the inspection varies depending on the expertise of the inspector. The insurance company may require changes or additional controls as a condition for insurance.

Industry or engineering standards

- These standards specify design, but generally do not indicate what steps should be taken during construction of a facility or fabrication of a piece of equipment to ensure that the design specifications are met.

Large Company Practices

- One company managed all facility construction in-house, using its own construction managers to supervise local construction workers, to ensure that the plant is built according to its specifications. The other company hired outside construction firms like Bechtel, which it believed had superior expertise.

- The companies conduct extensive evaluations of a new facility and run start-up tests before moving into full production.

- Routinely, the companies test critical components that will be exposed to highly reactive materials or high pressures to ensure they meet specifications before they are installed. A company may also inspect the operations of suppliers of critical components or change suppliers if they have quality-control concerns.

Small Companies Practices

- Small companies rely on outside contractors if construction is needed. One interviewee expressed concern about this step, because small firms usually do not have the expertise to evaluate the quality of the construction work or the materials used.

PROCESS OPERATIONS AND MAINTENANCE

No matter how well-designed, a chemical process must be managed and run properly in order to operate safely. Equipment and safety systems must be maintained in proper working condition to ensure they operate as intended.

Federal Controls

- EPA inspectors periodically check process equipment for fugitive emissions violations, including evaluations of valves and seals, and examine pollution control equipment to ensure it is working properly.

- OSHA conducts periodic safety inspections, which focus primarily on physical hazards, such as heat and moving parts in machinery, and on the condition of safety equipment, like safety masks and fire prevention equipment. It conducts random inspections, and also targets inspections based on injury rates measured in terms of lost workdays.

- OSHA also conducts health inspections that assess in-plant concentrations of toxic chemicals for which Permissible Exposure Limits have been set, again targetting its inspections to industries with a high rate of past violations. Last year, OSHA inspected one in every five chemical manufacturing establishments under this system.

State Controls

- Many states administer pollution control programs and occupational safety and health programs in lieu of the federal agencies. While there is considerable variation among states, in some cases, these programs are more stringent and inspections more frequent than required by EPA. For example, New Jersey has inspectors stationed permanently at certain major facilities.

- Like the federal programs they replace, however, state programs have a limited and specialized focus, primarily on routine, continuous emission controls and safety provisions for workers. They do not review the industrial processes themselves.

Local Controls

- There is little routine inspection of chemical industry facilities by local authorities, other than some inspections by the fire marshal.

Insurer Controls

- While insurers generally inspect an operation only when the policy is first issued, they may re-inspect a plant with an unusually high loss record.

Large Company Practices

- The companies have explicit operating instructions for each chemical process. These cover normal operating procedures to ensure reactions proceed as intended and to maintain equipment in proper condition, along with appropriate responses to diagnose and correct problems that arise. The procedures are revised any time the process is modified and are also reviewed and up-dated periodically even when modifications have not occurred.

- Routine safety checks are built into the system at the plant and operator level to anticipate equipment failure and other problems. In addition, corporate headquarters conducts an intensive inspection of each plant on a fixed schedule, usually annually, which identifies problems and lapses in plant procedures and makes recommendations for improvement. One company commented that it is better at documenting the audit findings than it is the follow-up on recommendations, even though they routinely make the recommended changes.

- The companies train their supervisors, who train the operators, on procedures for operating a new process. New employees also receive extensive training; plant operators, usually high school graduates, undergo an apprentice period as well.

- The companies track accidents, or "unusual events," and the handling and outcome of the events. They look for patterns, which may indicate mismanagment or previously undetected flaws in the process or procedures, and will make changes if necessary.

- Headquarters keeps statistics on several safety indicators, ranking plants and rewarding managers on safety performance. The plants report lost workday accidents (when an employee is unable to come to work because of an injury sustained on the job) and injuries requiring in-house medical aid.

- The companies place a high priority on safety, which is reflected in the performance standards of their managers. Pay increases and bonuses are tied to the safety statistics and accident rates at all levels of the organization. Operators who repeatedly violate safety procedures are fired.

Small Company Practices

- The small companies interviewed have a less formal system of maintenance than the large firms, but also conduct routine inspections in-house. One firm, which operates around the clock, shuts down for two weeks, twice a year, to perform non-emergency maintenance and repair.

- The companies run batch process operations; the products they manufacture change frequently. Equipment is thoroughly cleaned and inspected between batches, providing a periodic safety check on the integrity of equipment.

EMERGENCY RESPONSE

Despite preventative measures, accidental releases and spills inevitably occur. Emergency response actions are intended to minimize the damage that results from of an accidental release.

Federal Controls

- Many federal agencies have responsibilities for hazardous releases that occur within their arena. For example, EPA requires that releases of certain hazardous substances over a specified quantity be reported and has broad authority to respond to such a release; it also requires hazardous waste generators to develop contingency plans to minimize the effects of a release of hazardous waste.

- In addition, DOT has requirements covering releases that happen in transit. OSHA requires companies to have emergency plans and safety equipment for releases that affect workers. The Coast Guard responds to spills in navigable waters. The Department of Interior has authority over releases on federal lands. And the Nuclear Regulatory Commission covers releases of radioactive materials.

- The National Response Team is a cooperative effort of all federal agencies with responsibilities for emergency response. Co-chaired by EPA and the Coast Guard, the NRT monitors exposure and, working with local authorities, directs containment and cleanup actions when a release occurs. There are multi-agency response teams in each Region that can reach the site of the accident quickly.

- The NRC requires nuclear power plants and surrounding communities to have emergency response systems in place, including offsite control centers, warning sirens, and community evacuation plans. Although these are intended to mitigate the effects of a nuclear accident, they have also been used effectively when chemical spills have occurred in the vicinity of the plant.

State Controls

- Many states have some system to respond to accidents or spills. One state had three response teams located around the state. These teams monitor environmental and health impacts, contain or mitigate the spill if no local or corporate response is available, and assist local agencies if the state determines evacuation is necessary. Although companies are currently allowed 24 hours to report spills, the state is developing a 20 minute response capability.

- Another state felt its response capability was inadequate. Its emergency response team is located in the eastern part of the state and is not able to reach other areas quickly. It is also designed to deal primarily with oil spills, and is not as well-equipped to handle chemical releases.

- Neither state required industrial facilities to have contingency plans for emergencies, beyond what is required for hazardous waste releases under RCRA, and did not require communities around industrial facilities to develop response or evacuation plans.

Local Controls

- Local authorities are the first line of defense in an emergency situation. In most communities, the fire department has primary responsibility in the event of an accident, and provides fire-fighting services to local industries.

- There is considerable variation in the capability of local communities to deal with disasters. Many communities do not have adequate equipment to handle a serious accident nor workable evacuation plans. Industrial facilities generally have some arrangement with local authorities in case of an environmental release and have provided them with limited hazard information on the chemicals in use in the plant. The adequacy of these arrangements, however, depend on the initiative and interest of the community and the facility management.

- NRC requirements for community preparedness in a nuclear plant emergency illustrates the problems facing local authorities. As a condition for licensing, NRC requires the community to have evacuation plans and annual drills, as well as adequate equipment and personnel to protect the community. Most of the communities involved do not have the resources to meet NRC standards; consequently, the nuclear facilities generally foot the entire bill for the community.

Large Company Practices

- Most of a company's emergency response measures are aimed at protecting the facility and its workers. Procedures lay out responses to foreseeable events, like equipment failure, fires, and spills. They establish a chain of command for emergency situations and an on-site command center that allows the manager to communicate with every part of the plant and direct emergency actions.

- Large plants are essentially self-sufficent in an emergency. They have fire fighting equipment on-site, including fire engines and water storage tanks, in addition to automatic fire supression systems. Plant employees are organized into fire brigades in which each employee has pre-assigned responsiblities. They also have medical units to treat injured workers, staffed by full-time paramedics. Emergency drills are held periodically to train workers and test preparedness.

- Although they have limited interaction with the surrounding community, the facilities generally have some arrangement with local authorities for assistance if a emergency grows beyond their ability to manage it.

Small Company Practices

- While the small companies have some amount of emergency equipment on site, such as fire extinguishers and sprinkler systems, they rely on local authorities for fire-fighting services and other assistance in a major emergency. Local authorities have some information on the chemicals in the plants, although they often have not formally developed comprehensive emergency procedures.

- As generators under RCRA, the companies are required to prepare contingency plans for spills and accidents involving hazardous waste. One company hired an outside consultant to conduct an extensive assessment of the plant and prepare complete plans, and found the results valuable. The company has sent the draft plan to local authorities for review and plans to go through the plant with them to ensure the contingency plan can be implemented effectively.

PRODUCT MARKETING

The risk from hazardous chemicals occurs not only during production, but also during use. Controls and practices in product marketing are aimed at ensuring that those who purchase hazardous materials are able to handle them safely.

Federal Controls

- Under FIFRA, EPA can restrict who can purchase and use certain pesticides. Under TSCA, EPA has the authority to restrict the sale and use of chemicals that it finds present an unreasonable risk.

- The Bureau of Tobacco, Alcohol and Firearms restricts the purchase of explosives.

State Controls

- States can further restrict pesticide use beyond what is required under FIFRA, but few have actually done so.

Large Company Practices

- Concerned in part for product liability, a company may reach beyond its boundaries to ensure that customers handle and use their products safely. For especially hazardous chemicals, a company may visit the customer's plant to evaluate its safety practices and provide training and assistance on the chemical's use. It may require, by contract, that the customer follow certain handling procedures. If not satisfied with a customer's procedures or performance, the company may refuse to sell the product.

Small Company Practices

- Since the small chemical producers interviewed sold exclusively to large companies, they were not concerned about their customers' ability to handle hazardous products. However, one company did provide proof that the big firms are concerned about the capabilities of its customers. After the small firm had ordered five drums of an highly toxic chemical, a representative from the supplier appeared at the company to find out what it would be used for and how it would be handled.

TRANSPORTATION

Accidents during transport are a frequent source of environmental release. Considerable quantities of hazardous materials can be released if a tank truck or rail car is damaged.

Federal Controls

- Under the Hazardous Materials Transportation Act, DOT has extensive requirements governing the transport of hazardous materials, focusing primarily on those with acute hazards. First, DOT provides information during transport: it requires shipping papers showing the identity, hazard class, and amount of hazardous material, and container labels and vehicle placards identifying hazards. It also specifies manufacturing requirements for containers and rail tank cars. In addition, DOT has banned the transportation of certain materials, and others must be approved before they can be transported.

- While DOT views emergency response as primarily a local responsibility, it supports local efforts through a widely-used guidebook with information on response and through the National Response Team.

State Controls

- Some states restrict transport of flammable and explosive materials on certain urban routes and on bridges and tunnels.

- States can be delegated enforcement authority of transportation regulations.

Industry Practices

- The Chemical Manufacturing Association maintains an emergency response center called CHEMTREC that provides response information for chemical spills and releases. CHEMTREC provides a 24-hour liason service with member companies, relaying information in an accident on the chemicals involved, response procedures, and first aid.

Company Practices

- Companies generally follow DOT requirements and design standards, but in some cases may go beyond federal requirements. (See section on Process and Equipment Design).

- Many large companies have a 24-hour emergency number to provide hazard, clean-up and first aid information for transportation accidents involving chemicals they produce. Some companies have staff available to respond on scene to major accidents.

POSTSCRIPT ON BHOPAL

During our interviews, we occasionally were told of activities that a state or company had undertaken in response to the catastrophic accident in Bhopal. Their concern was that it not happen here, and that it not happen to them.

State Actions

- One state has created a Chemical Safety Task Force composed of representatives from state and local government, the chemical industry, labor, and public interest groups. The purpose of the Task Force is to examine current safety practices and existing laws in order to determine whether additional legislation is needed to protect against catastrophic accidents. To support the Task Force, the state is conducting intensive chemical safety audits in six plants and is holding a series of public meetings to hear community concerns and provide information.

Large Company Actions

- Both of the companies had undertaken special self-investigations to assess the adequacy of their procedures in preventing significant, accidental releases of highly toxic chemicals. One company required its plants to identify the chemicals in use that, considering hazardous properties, volumes, and worst case scenarios, could potentially result in a significant release. It then intended to take a hard look at the way those chemicals were handled.

- One company intended to make public the identity and the hazard properties of the chemicals in use in the plant and hold informational meetings for the surrounding communities on the systems it uses to ensure its chemicals are handled safely.

Small Company Actions

- One company has joined with 12 of its neighboring industrial facilities to develop emergency plans and improve handling procedures. In phase I, the companies will develop plans that include certain elements, prepare maps for each facility that show the location of acutely hazardous chemicals using DOT classifications, and meet with the local fire marshall, and other local authorities to familiarize them with the plants and response plans. In phase II, the group plans to evaluate the chemical process, equipment and and safety practices of each facility, using experts from a different facility or outside consultants.

NATIONAL CODES AND STANDARDS

Aluminum Structures

- Specifications for Structures of Aluminum Alloys, The Aluminum Association

Boilers, Incinerators, Furnaces, Heaters & Burners

- American Petroleum Institute
- American Society of Mechanical Engineers
  Section I, II, IV, V, IX
- American Society for Testing and Materials
- National Fire Protection Association
- Underwriter Laboratories, Inc.

Buildings

- The BOCA Basic Building Code, Building Officials & Code Administrators International Inc.
- The Uniform Building Code, International Conference of Building Officials
- The Standard Building Code, Southern Building Code Congress International, Inc.

- American National Standard Minimum Design Loads for Buildings and Other Structures (ANSI A58.1), Amer. National Standard Dist. Used primarily for wind loads.

- Annual Book of ASTM Standards
  American Society for Testing and Materials

- Local Fire and Building Codes

Electrical and Instrumentation

- National Fire Protection Association

  NFPA 70 National Electrical Code
  NFPA 77 Static Electricity
  NFPA 78 Lightning Protection

- American National Standards Institute Standards

- Institute of Electrical and Electronic Engineers

- National Electrical Manufacturers Association Standards

- OSHA Electrical Standards - U.S. Department of Labor

- Instrument Society of America

- Illuminating Engineering Society

Electrical and Instrumentation (Continued)

- Insulated Cable Engineers Association
- Underwriter's Laboratories (UL) Standards for Safety
- American Society of Testing Materials
- Factory Mutual (FM) Technical Reports
- American Petroleum Institute's (API) Recommended Practices
- National Academy of Science - National Materials Advisory Board

Fire Protection Systems

- National Fire Protection Association Standards

11 and 11A	Foam Systems
13	Sprinkler Systems
15	Water Spray Systems
12	Carbon Dioxide Systems
20	Centrifugal Fire Water Pumps
22	Water TAnks for Private Fire Protection

Heat Exchangers

- Standards of Tubular Exchangers Manufacturers Association

Heating Ventilating and Air Conditioning

- American Society of Heating, Refrigeration and Air Conditioning Society Standards & Guidelines

Insulation

- Removal and disposition Occupational Safety and Health Administration requirements

Noise

- Code of Federal Regulation Title 29, Chapter 17, part 1910.95 Federal Register Vol. 37 No. 202 (90 dba for 3 hours) Hearing Conservation Amendment 1981
- Many state and local regulations

Painting

- Steel Structures Painting Council (SSPC)
- American Society for Testing and Materials and American Institute for Steel Construction
- Occupational Safety and Health Administration

Piping

- American Society of Mechanical Engineers

  ANSI/ASME B31.3 - Power Piping
  ANSI/ASME B31.3 - Chemical Plant and Petroleum Refinery Piping
  ANSI/ASME B31.9 - Building Services Piping

  plus 19 other standards for piping, pipe flanges, fittings and valves, including

  ANSI B16.5 - Pipe Flanges and Flanged Fittings
  ANSI B16.34 - Valves, Flanged and Buttwelding Ends

- Manufacturers Standardization Society of the Valve and Fittings Industry

  30 standards for valves and fittings, including

  MSS SP-54 - Quality Standard for Steel Casting for Valves, Flanges and Fittings and Other Piping Components - Radiographic Method
  MSS SP-61 - Pressure Testing of Steel Valves

- American Petroleum Institute

  14 standards for pipe, valves and fittings, including

  API 600 - Steel Gate Valves, Flanged or Buttwelding Ends
  API 601 - Metallic Gaskets for Piping, Double Jacketed Corrugated and Spiral Wound

- American Water Works Association

  AWWA C150 - Thickness Design of Ductile Iron Pipe
  AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids

- American Society for Testing and Materials
- Dozens of standards, including

  ASTM A 106 - Seamless Carbon Steel Pipe for High Temperature Service
  ASTM A 403 - Wrought Austentic Stainless Steel Piping Fittings

Piping (Con't)

- "Recommended Practice for Acoustic Emission Testing of Reinforced Thermosetting Resin Pipe (RTRP), Society of the Plastics Industry, New York, July 1983.

Pressure Vessels

- American Society of Mechanical Engineers (ASME) - Boiler and Pressure Vessel Codes
- American Petroleum Institute Pressure Vessel Inspection Code, for Maintenance, Rating, Repair and Alteration-API Standard 510
- National Board of Boiler and Pressure Vessel Inspectors - Inspection Code

Reinforced/Plain Concrete

- American Concrete
- A compendium of recommended standards and practices, American Concrete Institute, Detroit

Rotating Equipment

- American Petroleum Institute Codes & Standards
- American Society of Mechanical Engineers
- American National Standards Institute
- National Electrical Manufacturers Association Standards for Gas & Steam Turbines
- American Society of Testing Materials for materials used
- American Gear Manufacturers Association Standards
- American Friction Bearing Manufacturers Association Standards
- Compressed Gas Association
- American Gas Association

Safety - General Guides

- National Safety Council Occupational Safety and Health series of manuals

  1. Accident Prevention Manual for Industrial Operations
     Volume on Administration and Programs
     Volume on Engineering and Technology

Safety - General Guides (Continued)

2. Fundamentals of Industrial Hygiene

3. Industrial Noise and Hearing Conservation

4. Supervisors Safety Manual

- Prudent Practices for Handling Hazardous Chemical Sustances - National Academy of Science

- National Fire Protection Association - Life Safety Code

Storage Tanks

- American Petroleum Institute - Recommended rules for design and construction of large welded, low pressure storage tank
  API Standard 620

- American Petroleum Institute - Welded Steel Tanks for Oil Storage
  APE Standard 650

- American Petroleum Institute - Venting Atmospheric and Low Pressure Storage Tanks
  ASI Standard 2000

- American National Standards Insititute Specification Welded Aluminum Alloy Field Erected Storage Tanks

- National Fire Protection Association - Code for Storage of Liquefied Petroleum Flammables, Combustibles, Oxidizing Materials, and Codes for Explosion Venting.

- "Recommended Practice for Acoustic Emission Testing of Fiberglass Tanks/Vessels", Society of the Plastics Industry, New York, January 1982.

Structural Steel

- American Institute for Steel Construction

- American Welding Society

- American Iron and Steel Institute

- Annual Book of ASTM Standards, American Society for Testing and Materials

Water System

- Cooling Tower Institute
- American Water Works Association
- National Fire Protection Association