CHEMICAL PLANT

SAFETY AND LOSS PREVENTION

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ABSTRACT

Increased emphasis on safety and loss prevention over the last 50 years has engrained safety as one of the core values of The Dow Chemical Company. The safety emphasis starts at the very top, with the Environment, Health and Safety Committee of the Board of Directors and down through the company encourages participation of every manager, supervisor and employee. Safety performance is considered an essential measure of job performance for each employee.

The Minimum Requirements for Safety, Loss Prevention and Security and the Loss Prevention Principles have been a successful system for applying the hard-won lessons of the past to a wide variety of facilities around the world. They provide a system and guidelines that require local management to develop specific programs to meet local needs but still remain consistent with corporate goals. Such programs thus become locally owned and line driven.

A number of programs have been developed by the company to meet the unique needs of the chemical process industry and Dow's decentralized management system. They include requirements for:

Reactive Chemicals Safety
Capital Project Reviews
Local Safety Regulations
Emergency Planning
Employee Training and Participation
Audits
Technology Centers
and others

These programs depend upon and develop a high degree of employee and supervisory participation. They have resulted in continued improvement in safety and loss performance. But Dow is not alone in safety. In the United States, the Bureau of Labor Statistics, reporting on Occupational Safety and Health Administration data for 1985, records the chemical industry as having the lowest frequency of recordable injuries in the manufacturing sector. These programs are dedicated to continued safety for chemical industry employees, customers and neighbors.

CHEMICAL PLANT SAFETY AND LOSS PREVENTION

Today, I would like to review the safety system that has developed over a number of years in our company. A system that is an overall approach to safety and loss prevention. A system that has become so engrained in the fabric of the company that we have come to regard safety as one of our core values. A system that provides the bases and techniques for hazard control but requires the local unit to develop a specific program that they can call their own.

The system I'll try briefly to describe to you, is one that starts at the top but also starts at the bottom and operates from a world-wide set of common requirements.

To provide a frame of reference, the program is an evolution of concepts that began in the 1930's when Dow was a single manufacturing location in Midland, Michigan. As a matter of interest, I have in my files a letter to Doctor Willard Dow, then president of the company, and dated December, 1948, announcing the formation of an Executive Safety Council as part of a program to improve the safety performance of the Texas Division. Today, the program continues developing to meet the changing needs of a global company, with 97 manufacturing sites in 30 countries of the world.

Approximately half of the employees, capital and sales are outside of the United States. Five manufacturing sites are located in Japan. The structure I review today was well into effect by the mid-1970's.

These, then, are the concepts we use to assure the safety of our employees, our neighbors, and our customers.

1. Safety starts at the top with the board of directors committee on Environment, Health and Safety (EH&S).

   First established in 1979 by amendment to the by-laws of the corporation, the committee has been twice modified to expand the scope and structure. Chaired by an executive vice president of the company, it now consists of 6 directors (5 inside, 1 outside) and 1 ex officio member.

   "The Environment Health & Safety Committee shall have the authority and the responsibility to assess any and all aspects of the company's decisions that pertain to operating policies and practices at its facilities to determine their impact on worker safety and health and on the environment in and around its facilities and to make recommendation to the board of directors and the management of the company."

The chairman and line members of the committee have the authority to assure that, where Dow products are involved, immediate action is taken anywhere in the Dow world when necessary to protect our employees, the public, our customers and the environment.

The committee meets prior to each board meeting and reports at each board meeting. They normally review the environmental, health and safety performance of the global company and review any significant incidents (injuries, losses, unplanned events, etc.). They review of one or more major programs in the area of environment, health, safety, security or loss prevention and may support, reject, suggest modifications or simply be informed. Discussion is likely to be informal, far ranging and questions are encouraged.

The EH&S Committee has several effects on the related programs in the corporation.

a. It demonstrates clearly to both the employees and the stockholders, the importance that this company puts on safety.

b. It provides direct safety performance information to the board of directors.

c. It provides a face to face forum between the directors and persons developing and/or conducting programs in the company that have an impact on EH&S.

d. It assures that the environment, health and safety emphasis is global in nature.

I should observe at this point that almost 50 percent of our board of directors have had international experience in the company and over 75 percent have engineering or scientific backgrounds. The problems of global safety are well understood.

2. Safety starts at the top but is the responsibility of every employee. The management of safety is the direct responsibility of line management - not the safety department, not the industrial hygienists, not the environmental control people.

To quote from our safety policy -

"Safety performance and attitude shall be considered major and essential employee job performance measurement criteria. Safety, Loss Prevention and Security are the direct responsibility of line management and are important measures of managerial performance. Line management has a responsibility

to monitor and assess all changes in process technology and work procedures in order to continue to provide a safe, secure work environment."

3. The third broad concept is that Dow has developed and we live by the Minimum Requirements for Safety, Loss Prevention and Security. The basis upon which each area and their respective units can build their own specific program.

   Signed by the executive management of the company, starting with the chief executive officer and including each of the area presidents, the Minimum Requirements contain 50 elements. First issued in 1976, the third edition is dated April 1984.

In the length of time we have available, I want to touch on 7 of the minimum requirements. Although almost all have some application to our discussion today, I want to talk about these in particular because they relate especially to the subject of the hazards of the chemical process industry or because they are especially important in our management system - a system of line responsibility with EH&S staff support and review where responsibility and authority is required from the top to the bottom of our organization. It is a system where, as our basic policy states

"Every employee is expected to comply with established rules and procedures as a condition of employment and to participate in the Safety, Loss Prevention and Security program."

"A Safety, Loss Prevention and Security function is provided by the Company, on a Corporate, Area and location basis, to assist line management in implementing these responsibilities."

In Dow, the SLPS function is heavily field oriented. The number of persons involved is very small at the upper staff level but becomes proportionately greater as one moves from the Corporate SLPS organization to each of the geographical area SLPS organizations (there are 6) to manufacturing division and location groups. Most safety staff positions are filled from highly rated line personnel as interim assignments. Such assignments bring highly qualified, practical persons to the safety effort and eventually return motivated, safety-oriented managers to the line organization. As a result, the success of our program depends heavily upon the acceptance of responsibility by the line manufacturing manager and his push to improve safety performance. We refer to the system as being "line driven" and, indeed, it is. Safe performance occurs because line management expects it! And organizes for it!

The primary emphasis is placed on prevention of incidents. Here are some of those Minimum Requirements that are critical to our performance.

Reactive Chemicals

The chemical process industry can produce its myriad of products because the materials used are reactive, but that very characteristic creates the potential for problems. Process design, plant operation and material handling and disposal must consider the possibilities and effects of material misidentification, impurities, loss of temperature control, loss of inhibitors, incorrect ratios, incomplete reactions, loss of utilities, and related problems. Operating procedures will include steps to prevent such abnormalities to such an extent as is possible and to identify and deal safely should unplanned reactions occur. Seveso and Bhopal were reactive chemicals incidents.

The Dow reactive chemicals program was developed in 1966 and is administered by the research organization.

> "Each location shall have an active and appropriate reactive chemicals program. Regular reviews of process reactive hazards shall be required for existing processes, new processes and whenever key personnel or a process is changed, as well as a

thorough review of laboratory or pilot plant data prior to scale-up."

Annual training is required for all employees who work with reactive materials, whether in research, development or production.

Reactive chemicals hazard evaluation procedures must consider structural formulas, thermodynamic properties, flammability, reactivity data with air, water, other chemicals, and a primary screening test such as Differential Thermal Analysis (DTA). Initial evaluations are likely to lead to more specific tests such as Accelerating Rate Calorimetry (ARC), Drop Weight Impact Sensitivity, Differential Scanning Calorimetry and others. These tests became the basis for process system design.

Capital Project Reviews

"All capital projects during the design and construction phases shall have Safety, Loss Prevention and Security reviews including reactive chemicals and industrial hygiene. They shall be given pre-startup audits."

The reviews are progressive from the early stages of conceptual planning thru process design, detailed design and pre-startup. Aspects including fire and explosion prevention and control,

chemical reactivity, industrial hygiene, personnel safety, location and spacing, among many others are considered by the multi-disciplinary reviewing teams. Depending upon the situation, reviewing techniques will include, Checklists, "What If Analysis", HAZOP, Fire and Explosion Indices, or others. Similar reviews on a smaller but equally critical scale are required for even apparently minor plant/process modifications. We've learned through experience that control of change is necessary to control of safety in the chemical process industry.

Regulations

> "Each location shall have safety regulations equal to or better than applicable government safety regulations and shall provide methods in the organization for monitoring compliance to same."

Corporate guidelines and Loss Prevention Principles are provided for the guidance of area and local units in preparing safety standards, design guides and operating procedures that are consistent with local governmental language and industry norms. Corporate guidelines range from Accident Investigation to Reactive Chemicals Programs and include such things as Emergency Planning and Warehouse Ratings, etc.

The manual of Loss Prevention Principles (LPP's) is maintained as a current book of best loss prevention practices for plant design or modifications throughout the Dow world. The principles include information on such subjects as relief systems, pressure vessels, plant layout, fire control, storage of chemicals, fired equipment and many more. The LPP's have been a combined effort of process engineering groups, technology centers, manufacturing, research, and loss prevention representatives around the Dow world. As a matter of interest, computerized programs developed in our Michigan Division Process Engineering group for two-phase flow in relief vent systems dates back 17 years. The manual is a living document, continuously being adapted to technological advances inside or outside the company. Copies are available to every Dow engineering and manufacturing unit.

A tested coordinated Emergency Plan is necessary for the protection of our neighbors in the unlikely event that all of the preventative, control and mitigating procedures fail.

Emergency Planning

"Each location shall maintain an emergency plan which:

-- Provides for all people (Dow and non-Dow)

-- Provides a firefighting organization

-- Is coordinated with the local community and industrial neighbors

-- Is field tested and documented at least annually

-- Covers all potential incidents relative to that location, e.g. utility loss, hazardous/toxic release, fire, explosion, civil unrest, bomb threats, and natural disasters."

Field testing is the only method of determining the ultimate adequacy of such plans. As an example, three days before the tragic accident in Bhopal, our Midland plant, the second largest location in the company simulated a chlorine release with vapor dispersion across the fence line and into the local community. Involved in the exercise were units of the local police, sheriff, hospital, ambulance and emergency control organizations. The exercise included such areas as schools, businesses and a nursing home. Newspaper, radio and television reporters participated in the exercise. Similar scenes are repeated many times yearly around the world in locations where Dow facilties handle hazardous materials.

Guidelines require that elements of unit plans be tested at least quarterly and that location/site-wide plans with community involvement be tested at least annually.

Employee Training and Job Operating Instructions

> "Each location shall have and observe policies and requirements that provide for initial and continuing training of all employees."

Safety plays an integral part of, and sometimes the majority of, employee training programs. New employees who will be plant operators complete courses in the basic principles of equipment operation and safety. Their advancement to higher level operating responsibilities is, in most locations, dependent upon completion of advanced courses in the chemical unit operations, process control and procedures related to their particular plant or laboratory. Group interaction plays a significant role in the program thru plant and laboratory level safety committees and regular monthly safety meetings.

At a somewhat more advanced level, during the last four years technical, professional, supervisory and lead operating personnel have been training through a case study exercise that we call the "Dowville" exercise. Several five person teams of participants compete in a two and one-half day exercise of investigation, analysis and recommendations following a serious accident at a hypothetical plant (Dowville). Process flow sheets and specifications, reactive chemical analyses, operating procedures

and videotaped news releases and interviews of the employees in the hypothetical accident provide a close-to-life background against which the participating employee can apply the lessons presented by experienced resource persons from line management. Almost 4000 employees from around the Dow world have been thru the exercise. We've developed derivative case studies that apply to materials handling processes and to fired heaters.

Let me also speak briefly about motor vehicle safety training. National Safety Council data in the United States indicates that 35 percent of all industrial fatalities are as a result of motor vehicle accidents. Long-term data from our own experience confirms that level.

We began requiring the mandatory use of automobile seat belts on company business in 1964 and by the early 70's were requiring every person who drove a motor vehicle as part of their job to complete a defensive driving course. Today we've gone beyond that level of training and now provide commentary-drive training and, in a number of locations, are providing and requiring drivers to complete "advanced driving skill" courses. Such training programs, coupled with required standards for our company motor vehicles, have reduced the frequency and seriousness of work-related motor vehicle accidents to about one-tenth of that of the general population. Many of our organizations, such as sales offices, regularly recognize the driving safety accomplishments of the sales force as additional motivation.

Unfortunately, I do have to report that during July of this year, one of our young salesmen in Brazil was fatally injured in a head-on collision with a truck. That accident ended a period of 5-1/2 years and over 1,800,000,000 kilometers of fatality-free driving by Dow employees. According to available safety statistics, driving that distance here in Japan would typically have resulted in 55 fatalities. Safety training saves lives!

Our set of minimum requirements outlines what is expected at all locations. It is important to have assurance that the requirements are being met. That assurance is gained thru:

Audits

> "Each location shall have regular internal and external audits of their operations for compliance with the Minimum Requirements."

However, equally important to us is the use of audits as a training tool/learning experience for the recipient. We find that the greatest benefit comes from the act of preparing for the audit. Consequently, we also make a great deal of use of self-audits.

A typical Dow process plant can expect to be audited from two to six times per year for conformity to some aspect of Dow programs.

Here is a partial list of audits with typical frequencies:

TYPICAL AUDITS	FREQUENCY
Tech Center/Oper. Discipline	2 Yr. Min.
Minimum Requirements	Annual
Loss Prevention)) - Insurance)	3 Yr.
Reactive Chemical	2 Yr. or
Industrial Hygiene	Annual
Plant Health	5 Yr.
Environmental	Area Std.
Safety & Housekeeping	Weekly - Quarterly
Occupational Health	Annual
Terminal/Whse. Loss Prev.	2 Yr. (U.S.)
Critical Instr. Reviews	Area Std.
Electrical Emphasis	Area Std.
Pressure Vessels, Reliefs	Annually
Electrical Grounding	1 - 5 Yr.
Hazardous Material Containment	1 - 2 Yr.

Finally, I want to talk about the system that we think is the key to our success in applying these requirements to the 450 process plants in almost 100 locations around the world. We consider the Technology Center concept to be the crown jewel in our manufacturing management system.

Technology Centers

> "Each manufacturing plant at a site shall use the minimum safety and loss prevention guides as developed by the technology centers for their particular process. Technology centers and the manufacturing plants shall perform safety and loss reviews of new capital projects and regular safety and loss reviews of existing plants for conformance with process technology guidelines or best available Dow technology where Technology Centers do not exist for the subject plant."

Each of the technology centers centralizes manufacturing technology within a product/process area of expertise. We have technology centers for styrene monomers, urethanes, S/B latexes, chlor-alkali, ethylene, high pressure polyethylene and others for a total of 37 centers. 97% of our manufacturing plants relate to a technology center.

A technology center is organized and staffed by a major manufacturing manager with engineering and research support, whenever a given process/product plant exists in more than one location.

Originally developed to provide worldwide consistency in new plant design, the tech centers now also provide plant performance comparisons, design guidelines, learning experience exchange, problem-solving

support and superlative safety and loss prevention audits and support. Thru their intimate knowledge of their process, they are able to apply all of the safety and loss prevention programs of the company with a rifle shot precision to their plants around the world. They play a key role in that critical process of conserving the hard-won know-how learned from past experience, of helping to assure that each of us benefits from the experience of our predecessors.

There are 45 more elements that make up our minimum requirements including:

Material Hazard Identification
Employee Training and Job Operating Instructions
Line and Equipment Opening
Testing of Emergency Alarms and Protective Devices
Combustible Dusts
Flexible Joints in Hazardous Service
Fragile Devices in Hazardous Service
Instrumentation
Pressure Vessels
Risk Analysis
Flammable Liquids and Gases
Leak and Spill Control/Containment
Fired Equipment
and others

The Results

Over the last five years, chemical exposures at Dow have been limited to the extent that they cause only 7 percent of our injuries.

Property damage losses have continued a downward trend, reaching record lows in the past three years.

The number and seriousness of reactive chemicals accidents has steadily declined.

Lost time injuries have declined to record low levels of 0.11 and 0.13 per million hours during the last two years.

In all of these indices, the area outside the United States, the parent corporate area, including the developing areas, have usually equalled or bettered this experience. As a matter of interest, Dow Brazil holds the company record of 31.8 million hours without a lost time work-related injury.

Dow is not alone in having an effective safety and loss prevention program. The lastest available data from the Bureau of Labor Statistics (1985) reports that in the U.S. manufacturing sector, the chemical industry had the lowest number of recordable injuries per hundred employees. We're dedicated to making and keeping it a safe place to work.

You may ask if we have made or contemplate any changes in our program. The answer, of course, is yes and no.

Yes, because during the last 3 years we have 3 times reviewed our operations around the world for conformance with the Minimum Requirements with special emphasis on the containment of hazardous materials. Like many companies we have further increased the emphasis on emergency planning with the communities around our facilities. And, we continue to critically review and reduce the inventories of hazardous materials at our plant sites. It has not been unusual to see a 50% or more reduction in inventory of in-process high hazard materials.

No, because we are continuing with this successful program that results in the acceptance of responsibility and the application of a high degree of professionalism and participation by managers and employees in the line organization.

We don't often get recognition in the headlines but our program is dedicated to providing the highest levels of safety for our employees, our customers and our neighbors.

I will be glad to answer any questions in the time remaining.