Planning for Chemical Process Safety Management

BY ROBERT POLITO

Most industries are concerned with their public image as a good neighbor, providing benefits to their community. The community, in turn, expects a facility to be in compliance with various state and federal environmental laws intended to protect public health and the environment. In reality, many industries find it difficult to comply with the increasing number of environmental regulations.

If a facility fails to comply with environmental laws, fines of up to $25,000 per day can be levied and criminal action can be taken by USEPA and other regulatory agencies. Public perception and environmental concerns require a facility to go beyond the reporting requirements of SARA to reduce environmental risks. The greatest and most visible environmental risk for any industry is a sudden, accidental contaminant release; it is increasingly important for a facilities manager to enact measures to reduce the potential for such a release.

Three states—New Jersey, Delaware, and California—have passed laws requiring toxic catastrophe prevention programs. These laws strengthen the risk reduction activities of facilities involved in the manufacture, storage, transfer, disposal or use of certain toxic chemicals.

One potentially far-reaching component required under the Clean Air Act Amendments is the “Chemical Process Safety Standard” enacted by the Occupational Safety and Health Amendments in 1992. The standard's purpose is to prevent or reduce the risk of a release of a toxic or flammable material which could cause a catastrophic accident. Facility owners who have highly hazardous chemicals on-site (and above a threshold quantity) are required to identify possible hazards and implement a process safety management program. This includes: having up-to-date process information; performing operator training; completing a hazard analysis and risk assessment; and having an accident investigation procedure in place. The Standard affects a wide variety of facilities and greatly

Sample Graphical Output
From the DEGADIS+ Dispersion Model

Accident Scenario:
Simulations, such as this sample air dispersion model, may be used to assess risks to human health and the environment following a toxic substance release. A risk reduction program can then be designed to reduce those risks.
impacts manufacturers of petrochemical, organic and inorganic chemicals, and paper and pulp products.

ELEMENTS OF THE PSM PLAN
A process safety management plan consists of numerous elements. The following are among the most important: contaminant identification and site data; equipment review; process hazard analysis; risk assessment; program review and recommendations; employee involvement; hot work permits; and written process safety management program. Each of these aspects of the program is discussed below in more detail.

Contaminant Identification and Site Data
The list of Highly Hazardous Chemicals from OSHA’s Process Safety Standard includes toxic and reactive chemicals which present a potential for a catastrophic event at an above-the-threshold quantity. Any operation that is involved in using, storing, manufacturing, handling, processing, moving (or any combination of these activities) a highly hazardous chemical must comply with this program.

Basic site information is needed to complete the program, including:
- process drawings and diagrams
- pipeline listing
- detailed equipment specifications and drawings
- instrument specifications
- trip and interlock logic sheets
- electrical one-line diagrams
- electrical area classifications
- fire water system diagrams
- sewer system diagrams

If the above information is not available or current, it should be developed.

Equipment Review
Information pertaining to equipment in the process which utilizes a highly hazardous chemical should be reviewed. The review includes the following:
- materials of construction
- piping and instrumentation diagrams (P&IDs)
- electrical classification
- relief system design and design basis
- ventilation system design
- design codes employed
- material and energy balances for processes built after the effective date of the standard
- safety systems such as interlocks, detection and suppression systems, etc.

In addition, a review and detailed analysis of any accident and subsequent responses involving a highly hazardous chemical that have occurred over the past six years should be conducted.

Process Hazard Analysis
This analysis is a systematic process that identifies the potential release conditions and release points as well as the estimated quantities of an accidental hazardous substance release. Standard operating procedures, piping diagrams, process and instrumentation flow sheets, electrical one-line diagrams, electrical control schematics, operation and maintenance procedures, job descriptions, and inventories of hazardous substances are reviewed.

A state-of-the-art technology review for equipment involvement with the hazardous substance is then performed. For each process covered by the standards, a hazard and operability study (HAZOP), failure mode and effect analysis, fault tree analysis, or “what if” checklist may be used to complete the hazard analysis. The actual method used in this last step is normally a function of the results of the facility and standard operating procedure review.

Risk Assessment
Risk assessment is a systematic analysis which characterizes the risk or potential for harm to human...
health and the environment due to release of a hazardous substance. The risk assessment process is partially based on the contaminant identification and process hazard analysis. The identified hazardous substance, the potential release quantity and the duration of release are necessary aspects of any risk assessment.

Once these items are defined, the risk assessment examines various exposure routes (surface water, soil, air, etc.), exposure levels for each of these routes and the estimate of the exposed population. Paper calculation, simple dilution models or complex computer simulation models may be used to determine the amount of a particular hazardous substance that reaches a receptor in a given period of time. An example of an air dispersion model graphical output is shown on page 22. The particular model will be chosen based on a release scenario defined by the hazard analysis.

Toxicological information or effects data for each of the contaminants is compared to the estimated levels of exposure, and probability of harm is assessed. After human health and environment risks are assessed, a risk reduction program can be designed to reduce those risks.

Program Audit and Recommendations
Periodic reviews of the process safety management plan help to assure a strong program. All employees involved with the highly hazardous process should be involved with the review. Each element of the program must be audited and deficiencies promptly corrected.

Employee Involvement
All levels of facility employees must be involved with the process safety program. Involvement of operators in hazard analysis, development of SOPs, incident investigation and training are all required by the OSHA standard.

An evaluation and inspection of all plant process safety documents, reviews with the facility personnel and identification of those procedures and activities which do not meet the specifications of OSHA should be completed.

Hot Work Permits
Several major industrial accidents in the 1990s have been related to problems involving inadequate control of flame and sparks. The plant engineer must identify hot work operations, and permits must be issued by the facility. Control of all contractor work in highly hazardous process areas is essential.

Written PSM Program
A written process safety management program formally describes a facility’s plan to maintain process safety. The program clearly defines responsibilities for implementing each element of the program. It also states the method the facility will use to manage process safety (i.e. who, when, why). The written program covers the technical elements and management-related aspects of the facility program.

Measures for updating state-of-the-art equipment, the placement of secondary containment vessels, modification of process operations, enhanced personnel training, a reduction in the amount of the hazardous substance in inventory, and preventive maintenance procedures are all essential. Safety procedure and accident investigation modifications are also necessary.

REDDUCING THE RISK
The process safety management program should contain a schedule for the implementation of risk reduction measures and review/update. Such plans could outline emergency response activity, emergency equipment and coordination with state and local emergency agencies in a written format.

A process safety management plan requires continuing commitment from facilities management, with annual reviews and updates to ensure long-term usefulness. Benefits range from safer workplace conditions, positive community perception and public relations to a reduction in potential liability. Without a successful risk reduction program, a company may not only endanger human health and the environment, but risk fines, negative publicity, decline in sales and significant remediation and legal costs.

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