Making it safe: process safety management in Canada

by Diana Del Bel Belluz, P.Eng., and Lyle LaLonge

In 1984, a tank at a pesticide plant in Bhopal, India, leaked five tons of poisonous methyl isocyanate gas into the air. Authorities said at the time it was the worst industrial accident in history, killing more than 3000 people and permanently injuring tens of thousands. Investigation revealed that a number of management system failures led to the incident, including: the use of low quality construction material, cutting down on vital safety measures, and the adoption of hazardous operating procedures. After Bhopal, a Canadian government/industry committee determined that "the possibility of a major industrial accident does exist" here. Ask yourself: "Could a process-related incident occur where I work? If so, how well is my company prepared to respond?"

What is PSM?

Process safety management (PSM) is a systematic approach to minimizing the occurrence and adverse effects of process incidents to people, the environment, assets and production. PSM is based on the understanding that incidents are rarely caused by a single equipment failure, human error, or environmental condition. Rather, most incidents occur due to one or more failures in the safety management system to adequately anticipate, prevent and mitigate incidents. PSM is defined as "a program or activity involving the application of management principles and analytical techniques to ensure the safety of process facilities." It is not occupational health and safety, industrial hygiene, environmental management or preventive maintenance, although all of these should integrate with PSM efforts. An effective PSM system will cover the 12 elements shown in Figure 1.

Root cause analysis

Too often, analysis of incidents stops at identifying the obvious and immediate (proximate) cause of an event. In order to prevent an occurrence or recurrence, it is necessary to identify the root (systemic) causes and fix the corresponding deficiencies in the management system. Root-cause analysis is an exercise to determine the underlying contributing factors that may lead to an incident.

Comprehensive root-cause analysis is usually applied when investigating serious incidents. Less formal approaches, such as the "why" technique, are useful in the analysis of near misses or audit findings. Just keep asking "why" to get beyond the proximate cause and to the root cause(s).

Addressing a proximate cause will not prevent a deficiency from reoccurring. Addressing root causes will help to prevent incidents from occurring again, and will likely prevent other situations that could arise from an inadequate understanding of the hazards involved.

The PRIM database

In 1998, the Canadian Chemical Producers' Association (CCPA) began to collect PSM performance information through the Process-Related Incidents Measure (PRIM) database. The measure provides important data to demonstrate that the responsible behaviour of CCPA member companies does indeed result in fewer process-related incidents. PRIM is also a tool to drive continuous improvement efforts by identifying common weaknesses that provide the best opportunities for improving PSM. PRIM is a numerical count of process-related incidents by each CCPA member company in a calendar year. For each incident, the company reports the level of severity (serious, major, or critical) and a short description of the incident, including the underlying root cause and which PSM system element failed.

A process-related incident is any unplanned, sudden event that causes or is liable to cause injury to people or damage to buildings, plant, material or the environment where a chemical or chemical process is directly involved. In addition to PRIM reportable incidents, companies are encouraged to share information on near misses and higher learning value incidents (HLVI) for which they typically provide more thorough information used in conducting causal analysis.

Findings of PRIM data analysis

Sixty-five of 71 companies (accounting for 144 sites) reported on incidents that occurred in 2000. As some provided data only for the last six months of 1998, the data for 1998 and 1999 are combined. A total of 108 and 61 incidents (including PRIM reportable incidents, near misses, and HLVI) were reported for 1998/99 and 2000 respectively. The data were then analyzed by a panel of three chemical engineers with expertise in PSM: Lyle LaLonge, Steve Coe, P.Eng., of Dow Chemical Canada Inc., and Rob Cairns, P.Eng., from Bayer Inc.

Based on the description provided, the panel identified the most likely cause of each incident, in terms of the PSM element(s) that would be expected to guard against it occurring. In some cases, more than one PSM element was involved. The goals of the analysis are to determine the underlying systemic "root" causes of process incidents, to search for any trends that may occur over time, and to identify any opportunities to enhance PSM.

Figure 1 shows the results of the causal analysis sorted by PSM element. Unfortunately, in 10-15 per cent of the cases, there was not enough information to judge the actual causes of the incidents. The data is fairly consistent between 1998/1999 and 2000; however, there is not enough yet to do meaningful trend analysis. (Complete results are available from the authors, contact riskwise@sympatico.ca.) PSM elements requiring most attention are process and equipment integrity, process knowledge and documentation, and capital project review and design.

Within process and equipment integrity, the elements cited most often were preventive maintenance (PM) and maintenance procedures. This involves understanding what equipment is truly critical, establishing "risk-based" PM frequency, having procedures to carry out PM that can pick up faults, and ensuring PM findings are recorded and analyzed for trends on a particular piece of equipment or "family" of equipment. Maintenance procedures include Permit to Work procedures, ensuring that equipment is properly prepared and ensuring that personnel are well trained in carrying out tasks.

Under process knowledge and documentation, the elements that appear most frequently are process and equipment design, protective systems and operating procedures. This last area covers having sound procedures understood and accessible by all personnel, having them reviewed and updated following any changes, ensuring they cover all phases of operations including emergencies, ensuring they cover plant operating limits and clearly communicate the consequences of deviating from established operating limits.

Within capital project review and design, the elements cited most frequently were hazard reviews and process design and review procedures. Hazard reviews involve ensuring hazards and associated risks are understood and striking an appropriate balance between procedures versus hardware methods of managing hazards and risks. The earlier in the design process that hazards are identified, the better the opportunity to select engineering methods (changes to equipment and design) rather than procedural methods (relying on people) to reduce risks. Process design and review procedures involve ensuring that those responsible for operations clearly understand design intent and safe operating parameters.

Challenges in collecting and analyzing PSM data

The data collected to date is useful for crude analysis of underlying systemic cause(s). In order to provide more detailed conclusions, it will be necessary to have better descriptions of incidents in order to identify underlying causes. Most importantly, companies will need to look beyond proximate causes and use appropriate incident investigation techniques to provide enough information to uncover the root ones. That some companies have been very forthcoming in sharing data on near misses and higher learning value incidents is promising however.

For information on Canada's coordinated effort to support the proliferation of process safety management as a way of preventing major industrial accidents across a wide range of sectors, contact Graham Creedy of the Canadian Chemical Producers' Association at (613) 237-6215.◆

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Figure 1: PRIM Data by PSM Element