CCPS Process Safety Incident Database (PSID)

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The Center for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers (AIChE) has developed a *Process Safety Incident Database* (PSID). The database system has been designed to collect high learning value process safety incidents from participating companies, to consolidate these in a confidential database, and to allow these same participating companies to analyze the resulting data and information for trends and lessons learned. The *Process Safety Incident Database* is based on Exxon's Incident Reporting and Analysis System (IRAS), which has been modified to suit the needs of CCPS.

This paper will examine the attributes that contribute to the effectiveness of incident databases and the value that can be obtained from their analyses. The paper will describe the features and capabilities of IRAS and how Exxon uses the system for reporting and analyzing incident information. Finally, the paper will describe how IRAS was adapted into the CCPS *Process Safety Incident Database,* the process that is being used to develop and maintain the database, and the expected benefits to participating companies.

LEARNING FROM INCIDENTS

Information relating to previous losses elsewhere is an effective stimulus for loss prevention in many large organizations. The ability to learn from previous incidents has long been regarded as an essential aspect of any program designed to reduce the frequency and severity of future incidents. Nonetheless, many major events which capture media attention continue to implicate "failure to learn from previous losses" as a major contributor. While it is easy to discount history because of its uniqueness, it is more difficult to do so if a pattern of matching descriptive details and repetitive statistics are available. If obvious similarities are apparent between an existing operation and one that experienced a loss, follow-up action is more likely to be pursued and a future loss may be avoided. The CCPS *Process Safety Incident Database* provides such detailed incident history without specifically identifying the companies which sustained the losses.

Effective incident reduction initiatives typically consist of many inter-related programs, including root cause analysis of individual incidents, capture of incident information in hard copy or computer databases, and analysis of multiple incidents to find common or systemic causes. These activities are ultimately designed to provide information which will allow changes to be made to current or future equipment designs, procedures, training, or human-machine interfaces, all with the intent of preventing similar incidents from recurring.

Quantity, Quality and Diversity of Incident Data Are All Important

The value obtained from the analysis of multiple incidents is dependent upon

- the number of incidents in the database
- the type of information captured
- the quality of the information contained in each incident report
- the diversity of the incidents

(Diagram not shown in electronic copy)

Many chemical plants and refineries have systems in place to determine root and systemic causes of incidents, and to define remedial actions to prevent recurrence. An individual site may maintain a database of only its own incident information, relying on learnings from individual incidents or the analysis of a relatively small set of incidents to define improvements. Because individual sites often have special circumstances that may differ from those at other sites, such a process of incident investigation and analysis is generally encouraged. However, if only major incidents are captured at a site, many years may be required before the results of an analysis of the site's database can be considered meaningful.

Increasing the Scope and Diversity of Incident Data

As a database grows, both in the number of incidents captured and in the scope and diversity of the incidents making up the database, the potential for added value from the analysis of the database grows too. Sites can increase the value associated with the analysis of their respective incident databases through a number of means. One is to include in the database a greater number of less major site-specific incidents and/or near misses. (Less major in this context means incidents with less serious personnel injuries or less significant cost impact.) This approach maintains the concept of comparing incident information local to a site, but provides a more statistically significant and diverse database for analysis.

A second way to increase the value of a database is to compare its information to that of another database. In this way, an individual site can greatly increase the information available for decision-making regarding equipment design, procedures and systems. For instance, a refinery associated with a multi-national company could choose to obtain the incident databases from other refineries in its region (e.g., Europe), from all refineries in all regions, or from all operating sites in the company.

Incidents occurring within the industry, but outside the company, also provide fertile ground for valuable information. Many lessons learned from so-called "outside" incidents are often directly applicable to other company's operations. Similarly, databases which include incident information from multiple companies have the advantage of further broadening the spectrum of incidents on which analyses can be made, adding value to the overall incident analysis process.

It was this concept of creating a repository of incident information which would embody the attributes associated with effective incident databases that led to the creation of the CCPS *Process Safety Incident Database.*

CCPS INCIDENT DATABASE INITIATIVE

In 1995, a group of sponsor companies approached CCPS, requesting that an industry database be developed to track process safety incidents, with the focus on sharing "lessons learned." The CCPS Technical Steering Committee and the CCPS Managing and Advisory Boards approved a project to develop such a database.

An inter-company task force of chemical and refining companies was formed to determine the viability of the project. The task force was asked to determine whether there were existing databases that would be suitable for the project, or if a new database had to be developed. One of the existing incident databases which was considered was Exxon's Incident Reporting and Analysis System—IRAS. IRAS is Exxon's primary

company-wide computing tool for recording and analyzing employee lost time incidents and incidents meeting a specified direct dollar loss threshold. The CCPS task force concluded that IRAS was the most suitable system for the development of its database.

Exxon's corporate Environmental and Safety Department, and its affiliates, approved the use of IRAS by CCPS as the software for the PSID. Exxon has granted an evergreen, no-fee license to CCPS. The use of IRAS is granted solely to CCPS; the software is not available in any form to any of the companies participating in the PSID program. The license allows Kallista, the developer of IRAS, to modify IRAS for CCPS use, and to develop a software package (so-called "mini-software") to allow participating companies to search the database for information of particular interest to them.

IRAS Modified to Suit CCPS

IRAS was designed by Exxon with many of the features considered essential for successful database development and analysis, and most of these features were adopted by CCPS for the *Process Safety Incident Database.* IRAS was also modified in a number of ways to meet the needs of the PSID. For one, all references to Exxon were removed. In addition, IRAS contains an analysis capability based on Exxon's Operations Integrity Management System (OIMS). OIMS was not included in the PSID; however, in its place, CCPS substituted its elements of Technical Management of Chemical Process Safety (which formed the basis for the OSHA regulation on Process Safety Management).
The task force developed a number of additional changes to IRAS to meet the needs of CCPS and the participating companies. For instance, a tiered pick list was developed for Operation Type/Unit Operations (Figure 1). (Figure 1 not included in electronic version) Cost panels were modified to allow selection of one of five cost ranges, rather than requiring the exact cost. Ranges are similar to those required in CMA's Process Safety code data collection for Responsible Care. The follow-up panel was modified to list only follow-up actions.

CAPTURING FACTUAL AND ANALYTICAL DATA AND INFORMATION

The most useful incident databases include both factual and analytical information. Factual information includes a description of the incident (can be a detailed description or a brief description, or both), and specific data associated with the incident, such as type of equipment, processing unit, initiating event, and phase of operation. The latter is often captured in so-called pick lists, which provide the ability to directly select information in logically oriented lists. The *Process Safety Incident Database* captures factual incident information in a series of pick lists endorsed by a PSID Working Group. These are shown in Table 1. (Table 1 not included in electronic version)

This factual information is essential for providing a complete and thorough historical record of the incident. The database in which incident information is to be stored must provide the opportunity to capture all the important information about the incident since this information will be the basis on which all subsequent analyses are made. Its completeness will directly affect the ability of an organization to sort and group incidents according to specific categories. One way this can be accomplished is by designating certain types of information as "required."

Analytical information captures the results of analyses performed at manufacturing sites to determine direct, root and systemic causes of incidents. Such analyses are performed on individual incidents based on site-specific guidelines, with the expressed purpose of ensuring that recommended actions resulting from the analysis will prevent a recurrence. A number of root cause analysis techniques are available; the most appropriate method should be selected by the investigator based on the seriousness and complexity of the incident.

The *Process Safety Incident Database* provides means for capturing analytical information about an incident. There are text fields that require the submitter to provide both a brief and full description of the incident. Fields for Lessons Learned and Changes Made are also provided. In addition, the submitter can complete the pick list which defines which factors contributed to the incident, using the CCPS elements of Process Safety Management (PSM) as an outline. The results of incident analyses provide useful information for incident databases. By incorporating a common set of causal factors into the database, a site can determine which management systems are contributing most to its incidents and take steps to remedy. Many of these systemic causes may involve procedures, training or human factors.

In the end, the *Process Safety Incident Database* has 13 required fields and 4 optional fields, as shown in Table 1. The fields were designed to be suitable for both refining and chemical plant facilities.

Data Quality Determines Analysis Value

As with any database, the quality and completeness of the data and information captured will directly affect the usefulness of the subsequent analyses. Incomplete or incorrect data will significantly reduce the ability of an organization to obtain meaningful information from the database or to correlate the data from one incident with other losses. Data should conform to the standard process and equipment definitions that are highlighted in the Guidance Document. Standard picklist entries are preferred over the category "Other." All data must be factual and accurate. Any incident that is not logical and credible will not provide full value to the participants and could contaminate the database with useless information.

Completeness of the data will ensure that the participants can derive optimum learnings. When the data is deemed suitable for the PSID, all references to source will be destroyed and the data will be downloaded into the database. 1 While it is not possible to fully check the quality of all data submitted, the CCPS Database Administrator will test the logic of each event based on extensive personal experience. Questions will be referred back to the originator. Following review, the accepted data will be entered into the system and cannot be modified.

WORK PROCESS IN PLACE FOR *PROCESS SAFETY INCIDENT DATABASE*

A detailed work process has been developed to describe the steps associated with the collection, consolidation, and exporting of data from the *Process Safety Incident Database.* The process is shown in the flow chart (flow chart not included in electronic version) on page 281. Participating companies will be expected to provide detailed information for a minimum number of incidents each year. The incidents submitted should provide a potentially important lesson to be learned. Such incidents could result in fire, explosion, fatality, multiple injuries, significant release of hazardous material, or any other unique process safety incident as defined by the submitter. Significant near misses which are considered to have learning value may also be submitted.

In order to ensure that data submitted by different companies is consistent in format and value, a subgroup developed a standard input template. The 13 required and 4 optional fields in the database define the specific information requirements for each incident. The information for each incident will be completed on a Microsoft Word template included in the system. The template will be forwarded to CCPS for inclusion into the database. Some data input requirements, along with the associated rationale, are shown in Table 1.

Any company may participate in the PSID provided it is willing to contribute its process safety incident data. Such participants will have access to the database through CCPS. Only those organizations that submit their data will be able to obtain information from

the database. This feature is in place to encourage as many organizations as possible to submit and share incident data. Each company on an annual basis must submit a minimum number of incidents. The number of incidents is based on company sales and ranges from one to 10 incidents per year.

PSID Database Analysis

Each PSID participant will receive a copy of "mini-software" from CCPS. This "mini-software," which has been adapted from IRAS, will allow participants to analyze the database and generate reports. Periodically, the CCPS PSID Administrator will make the *Process Safety Incident Database* available to each participating company. Database analysis can be used to investigate information about one incident, or to analyze a group of incidents. To accomplish the latter, a process of creating and managing "lists," and generating reports on the lists, is used.

Lists are collections of incidents. List management will allow participants to develop a filing system for incidents. Two types of lists can be produced:

- Refreshable Lists—which are lists that contain only incidents that meet a specific query search criteria. Refreshable lists are typically used for grouping incidents by type, such as "all fires" or "all pump incidents."

- Nonrefreshable Lists—which can include any incident assigned to a list. These lists are used for special situations where the list is not based on a query, such as "all incidents with a catastrophic potential" (for OSHA PSM or EPA RMP, or other government agency requirements).

Standard Reports

The six standard reports available with the PSID "mini-software" are

- 2D Summary—one of the main analytical reports, the 2D compares one criteria (such as incident type, phase of operation, or equipment type) to incident count, and portrays it as a report or a graph.

- Cross-Tab—one of the main analytical reports, the Cross-Tab compares two pick list fields from the Database for those incidents meeting both criteria. It can be used to quickly define "hot spots" where incidents occur most often (for instance "fires during start-up" by asking for type of incident versus phase of operation).

- CCPS Key Learnings—for a list of incidents

- Follow-Ups—(changes made) for a list of incidents

- Incident Report—for all incidents on a list

- Contributing Factors—CCPS elements and components

Participants can also develop their own custom reports by using the capabilities of Microsoft Access. Figures 2 and 3 (not included in electronic version) are examples of some of the types of reports that can be produced.

A flow chart depicting the key steps in the PSID process is shown below:
(Chart not in electronic copy)

24 COMPANIES PARTICIPATING—COMMITTEES ACTIVE

At the current time, 24 companies are participating in the PSID. These companies are listed below.

Akzo Nobel	Occidental Chemical Corp.
AlliedSignal, Inc.	Phillips Petroleum
Amoco Corporation	Procter and Gamble
Celanese	Rhodia, Inc.
Caltex Petroleum Corp	Rohm and Haas Company
DuPont Company	Shell Oil Company
Eastman Chemical Company	Solutia, Inc.
Exxon Chemical Company	Syncrude Canada Ltd.
Fina Oil and Chemical Company	Texaco Group, Inc.
Mobil Oil Corporation	The Dow Chemical Company
Monsanto Company	The Lubrizol Corporation
Nova Chemicals	Union Carbide Corporation

(Chevron and Bristol Myers Squibb have joined since this paper was given)

A number of committees and subgroups have been formed to manage the PSID activity and to work specific issues. The Project Management Committee will have one member from each participating company and will govern the overall management of the database in conjunction with CCPS staff. A protocol for the PSID has been developed to define the workings of the program, including participant responsibilities, anonymity, costs, and the process for managing the database. The protocol is included in the Participant's Agreement. A Steering Committee, with representatives from six participating companies, has been formed to deal with ongoing operational issues such as costs, training, requests for waivers from the provisions of the agreement, fees for future participation, etc. The Steering Committee will advise the Project Management Committee on pertinent issues as appropriate.

Two subgroups have been formed—a Technical Issues Sub-Group, and a Guidance Document Task Group. The Technical Issues Sub-Group is responsible for identifying system problems and helping to identify potential enhancements in the system. They will prioritize enhancements and changes to the PSID recommended by the Project Management Committee. The Guidance Document Task Group is recommending the content and format for a "Guidance Document" to assist users in data entry, retrieval and analysis. They will review the draft document for user friendliness.

SPECIAL MEASURES ASSURE CONFIDENTIALITY OF PSID

The maintenance of complete confidentiality of the data in the *Process Safety Incident Database* is essential if companies are to willingly contribute incidents to the PSID. A number of special measures have been implemented to ensure the anonymity of the submitter. These include

- Contracts between CCPS and contractors hired to process confidential data contain strict requirements for maintaining the security and confidentiality of the data

- In order to ensure that data entered into the PSID would not accidentally identify the owner of the incident, such information as month and day when incident occurred, and city where incident occurred, is not required. In addition, year of incident and political subdivision (state, province, county) were made optional.

- Once an incident has been entered into the database and all quality control requirements have been met, all records (both electronic and paper) containing company identity, address or date of incident will be systematically destroyed.

- Information provided to the participants will include only aggregated data from the database or tailored reports, but no data from any specific participant.

- Companies do not have to submit incidents that might be involved in litigation or might be otherwise sensitive.

COST OF PARTICIPATION

The costs of establishing and maintaining the PSID is shared by the participants. Some of the costs of the early feasibility and development projects were provided by CCPS. The remainder of the initial costs are covered by a one-time assessment of those companies electing to participate in the PSID. These initial costs are $6000 for CCPS sponsors and $12,000 for other companies. Once up-and-running, the PSID will be supported by an annual fee for processing new data and maintaining the system software. The fee will support a contractor who will act as Database Administrator.

When viewed in the context of the information provided through the PSID, the costs associated with participation are considered very reasonable. The cost of conducting just one formal investigation for a major incident can easily range upwards of $20,000. If regulatory authorities, or third parties or external consultants, become involved, these costs will soar. The direct costs of an incident in terms of injuries, damages and lost profits can also be substantial. Participation in the PSID can help minimize the occurrence of such incidents.

EXXON'S APPROACH TO INCIDENT ANALYSIS

Exxon has established an Operations Integrity Management System (OIMS), which (similar to Process Safety Management—PSM) provides a framework for identifying, prioritizing and controlling risk in order to minimize the occurrence of incidents affecting people, facilities, and the environment.

One important element of OIMS involves incident investigation and analysis. This element requires a systematic approach for reporting, investigating, analyzing and documenting incidents, for determining where improvements to practices, standards and management systems are required, and for sharing lessons learned. All Exxon affiliates are expected to have systems in place to address these expectations.

THE VALUE OF IRAS TO EXXON

IRAS has enabled Exxon to maintain an effective corporate incident database, which currently contains nearly 10,000 incidents in electronic format dating back to 1975. Exxon Research and Engineering Company acts as database custodian. The database is regularly analyzed to determine trends and identify potential corrective actions. Analysis provides data and information for:

- Exxon's annual safety reports, including the corporation's Annual Report, which define the company's safety and environmental performance, including employee and contractor safety, major direct dollar losses, and oil spills.
- Periodic analyses of major chemical plant and refinery fires and explosions, and chemical and oil spills, including long term statistical trends in numbers and losses, distribution of root causes by equipment type, lessons learned, and recommended actions.
- Frequent ad hoc searches to supply incident information on specific equipment or operating units in association with design, R&D and consulting activities.

In addition to the corporate database, individual chemical plants, refineries, and regional affiliates also maintain incident databases. These sites and affiliates are also using the power of IRAS to analyze multiple incidents as a means of identifying common causes and remedial actions. At one chemical plant, analysis of IRAS data has helped identify areas of the site where high incident rates are occurring, leading to improvements in equipment maintenance and upgrading.

USE OF THE CCPS DATABASE BY PARTICIPATING COMPANIES

Within any large organization, there are several applications for an external incident database. From the executive level to the field, important questions are more likely to be raised and follow-up actions pursued if credible information is available relating to previous losses. Risk controls derived from a history of previous incidents are more likely to be approved by the legal and financial sectors and by shareholders.

At Syncrude Canada Ltd., a large oil producer in western Canada, external losses are currently used to draw attention to the importance of effective management systems. Even without an official database, significant events elsewhere are selectively analyzed for cause and appropriate lessons derived. (The exercise can be difficult and time-consuming, and is dependent on receiving correct information from outside contacts.) Syncrude's current operations are then reviewed to ensure that similar losses to those elsewhere cannot occur locally. This requires an in-depth analysis of our operations and

strengthens our overall understanding and awareness of process hazards and management systems. Staff is then assigned follow-up responsibilities for ensuring that appropriate safeguards are in place. Like Exxon, Syncrude is highly committed to process safety excellence and believes it can further enhance its systems for continuous improvement after receiving the CCPS PSID.

At the executive level, it is necessary to stay continuously abreast of trends that affect the industry in general and to take actions which are consistent with the best in industry. This executive awareness is important if an organization is to maintain a proper focus on loss prevention. An external database managed by industry can best provide this awareness; other sources of information such as the media will often distort or exaggerate loss statistics and they seldom address fundamental underlying causes.

At the business unit level, local managers need to be aligned to common industry problems that might affect their specific facilities and equipment. While safety forums and conferences provide an effective venue for such discussions, the initial awareness is often through a structured database. In the interest of safety, managers should assume that their facilities are as vulnerable as those which sustained losses elsewhere. Only after deliberation and follow-up should this relationship be challenged and a facility declared relatively safe. The event logic associated with a single set of data can serve as a template for asking important questions of staff members and developing an effective loss prevention strategy.

The full value of an event database is best realized by the process or mechanical engineer. Typically involved in the troubleshooting of process problems and the design of new facilities, engineers must understand what types of equipment are likely to fail in service and how such failures might occur. Table 2 (not included in electronic version) shows the potential results of an analysis of furnace tube failures from an external database. This understanding in turn leads to improved equipment and system design, and fewer failures. Industry best practices benefit as companies adopt stricter designs. The advancement of safety technology correlates to industry best practices. Finally, leading corporations recognize the value of structured data in helping to train their engineers.

At the field level, event data can influence the actions of process operators and maintenance technicians. Safe work practices and procedures should be tested to ensure that they address and protect against loss scenarios highlighted in the CCPS PSID. The importance of human factors has only been highlighted in the past decade. References to human failure-based events can help to focus on improved control schemes, graphics, ergonomics, training, procedures, work schedules and job descriptions.

Maintenance personnel, including both planners and inspectors, need to be aware of equipment trends in industry. Event data can help focus on types of equipment which are experiencing failures as well as actions taken by others to avoid subsequent losses. Inspection techniques, scheduling and maintenance practices can all be gauged against practices pursued by others as follow-up to major losses.

BENEFITS OF PARTICIPATION IN THE CCPS PSID

The *Process Safety Incident Database* will capture and store information relevant to many types of process safety incidents in a structured and consistent format. It will identify common causes and contributing factors to losses involving equipment, processes, and materials. In addition to driving loss prevention activities, the PSID will positively impact the safety culture in participating companies. It will

- Provide the capability to query and identify common factors contributing to incidents, such as equipment, operating unit, injury, process, chemical
- Provide designers with information on past incident and safety performance associated with processes, equipment, and chemicals being considered for new designs
- Allow participants to share their process safety experiences with others through narrative descriptions of lessons learned.
- Provide important information for conducting and improving the quality of Process Hazard Analyses (PHA's), including consequence analyses, at various stages in the process life cycle.
- Permit operating units to identify similar operations having either a high number of incidents or common contributing factors and thereby focus attention on critical variables.
- Assist in incident investigation by providing an industry reference for similar processes, equipment and chemicals
- Provide an industry benchmark for continuous improvement in all aspects of process safety.

SUMMARY

Effective incident databases provide users with the data and information necessary to evaluate the potential impact of incidents on their operations. Learnings can be obtained both from the evaluation of individual incidents, and from the analysis of multiple incidents for trends and lessons learned. The value which can be obtained from such databases is directly proportional to (1) the number of incidents in the database, (2) the type of information captured, (3) the quality of the incident information, and (4) the diversity of the incidents in the database.

The Center for Chemical Process Safety (CCPS) of the AIChE has developed a *Process Safety Incident Database* (PSID) to serve as an industry-wide system for collecting, consolidating and sharing high learning value process safety incidents from participating companies. The PSID is based on Exxon's Incident Reporting and Analysis System (IRAS), and is designed with the capability to capture the number/type/quality/diversity of incident information described above for effective incident databases.

Many benefits will result from participation in the *Process Safety Incident Database.* Participants will be able to generate complete individual incident reports, and to produce six specific reports with which various incident criteria can be compared and areas for improvement identified. Managers, engineers, designers, and process and maintenance personnel will all benefit from improved capabilities to design new equipment, conduct PHA's, investigate incidents, and troubleshoot equipment and process problems. Twenty-four companies are currently participating in the PSID. Additional participants will further strengthen the effectiveness of the PSID.