OTC
Owner Team Consultation

Effective Process Safety Management:
'Keep it in the pipe!'

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July 2018

Introduction

Process safety management (PSM) defines a framework for managing hazards in the process industries and is intended to reduce the frequency and severity of incidents resulting from releases of chemicals and energy.

This paper addresses the elements of a process safety framework through the stages of a project from concept design, to detailed design, to operations; and translates these into elements of a process safety management programme.

Process Safety Framework

Life-cycle of a process plant

A process safety framework incorporates 'cradle to grave' activities that encompass the life-cycle of a facility and are based on clear identification of potential hazards and the risk management programme to control the hazards.

Hazards are contained by multiple protective barriers, which may be physical engineered containment or procedural controls dependant on people. This means that a thorough PSM approach will need to address both physical and behavioural aspects of building and operating a process plant. Hazard elimination is better than prevention, is better than control, is better than mitigation, is better than emergency response!

Different approaches to safety are used during the life-cycle of a facility. During the concept development (front-end loading) phase, the focus is on inherent safety. During the detailed design phase, the technology has now been selected and the focus is on engineered safety. What fail-safe systems do we need and how do we design out operator error? Does it make sense to consider a fully automated facility? During commissioning and the operations phase, the technology and engineering is in place and the focus is on procedural safety. Procedural safety covers the availability of safe working procedures, suitably qualified resources, management of change procedures, etc.

Figure 1 shows a portion of the OTC Stage-Gate Model, the different approaches to safety and risk reduction effectiveness of each of these approaches. This simply says that technology selection and the use of inherently safer design has the biggest impact on the future safe operation of a facility.

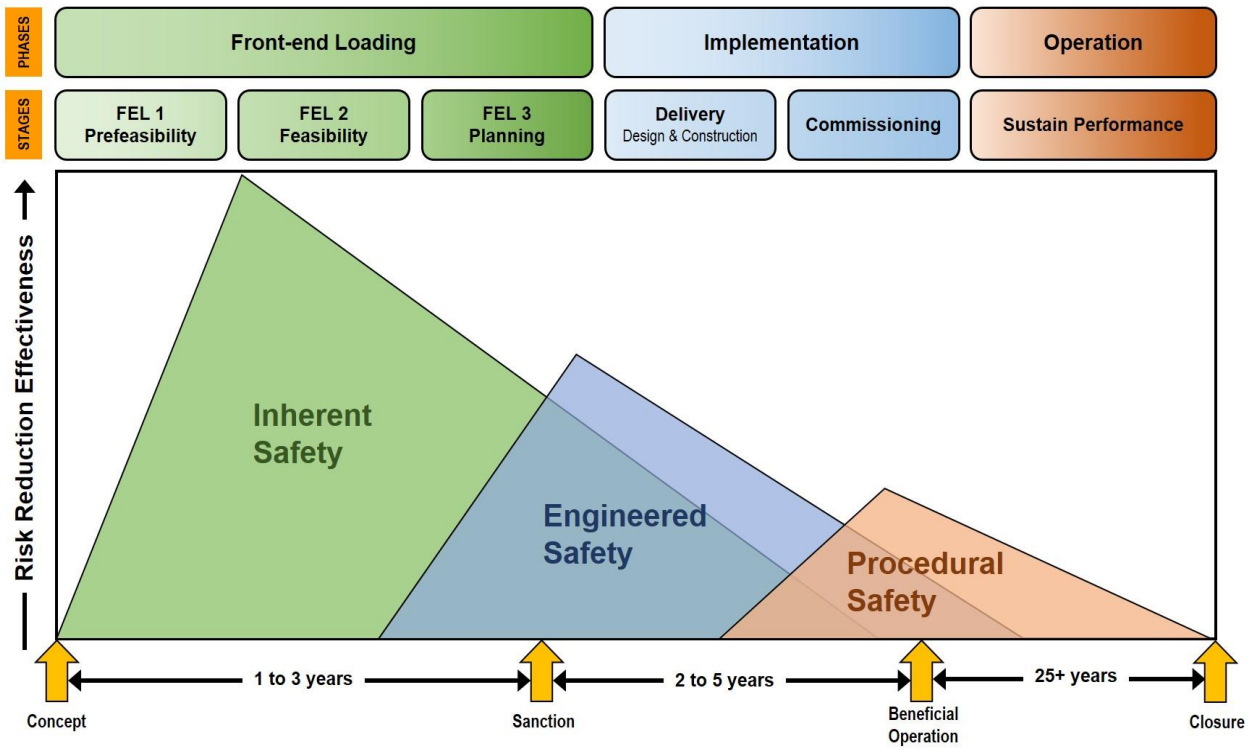

Figure 1: Safety approach and risk reduction effectiveness

The safety approach for the different life-cycle phases is discussed in more detail in the following sections.

Concept Design

Concept design of a new facility addresses selection of technology and defines the integrated process and major equipment requirements. Inherently safer design is used during this phase to ensure safer technologies are selected and engineered which are less likely to incur serious process incidents. In other words, this approach addresses elimination of hazards.

Inherently safer design principles are:

- **Intensification:** Consider the reduction in the inventory of hazardous materials and products in the facility;
- **Substitution:** Substitute hazardous substances like catalysts, additives and solvents with lower hazard materials;

- **Attenuation:** Attempt to keep operating temperatures and pressures as low as possible by prudent selection of technology and catalysts to reduce the operating severity; and
- **Simplification:** Simplify the design as far as possible and streamline the processes. A tank you don't have cannot leak…

Detailed Design

The detailed design phase looks at engineered risk reduction measures (engineered safety) and addresses layers of protection including plant (equipment), process and people. Risk reduction measures include prevention, control and mitigation.

The three strategies used during detailed design to prevent, control or mitigate hazards are:

- **Passive strategy:** Minimise the hazard via process and equipment design features that reduce hazard frequency or consequence;
- **Active strategy:** Engineering controls and process automation to detect and correct process deviations; and
- **Procedural strategy:** Administrative controls to prevent incidents or minimise the effects of an incident.

Plant Operations

Once the facility is up and running, hazard reduction relies mainly on plant process control systems (process) and on procedural controls (people). The plant will operate for twenty-five or more years, and hence from the start the company leadership need to demonstrate commitment to a culture of process safety.

Management of the facility must ensure:

- **Competent resources:** Provide adequate resources, safe work procedures and a proper training environment;
- **Safety culture:** Develop and sustain a culture that embraces process safety and lead by example. This includes the availability of safety resources, and a budget for safety training;
- **Safety compliance:** Identify, understand, and comply with all relevant safety codes and standards;
- **Continual improvement:** Put structures in place to continually enhance organisational competence; and
- **Operational discipline:** Management systems should maintain operational discipline and celebrate successes. Complacency should not be allowed to creep in at any time!

Process Safety Management Programme/Plan

Process safety management elements

To maintain focus on process safety, many companies draw up a PSM programme, define leading metrics and an integrated set of key performance indicators, and schedule frequent audits that probe each element of the programme. These PSM programmes typically comprise six, or more, elements.

The US Occupational Safety and Health Administration (OSHA) lists fourteen elements of a process safety management programme for employee protection, supported by management commitment, as represented in Figure 2. This is just one example of the elements of a PSM programme and provides an excellent checklist of what could be included in an effective PSM programme for your organisation. The names of the different elements are self-explanatory, except for the one called 'trade secrets'. In the past, some companies kept process information secret from their own employees under the guise of proprietary information. 'Trade secrets' states that operations and maintenance employees have the expressed right, under this element, to be made aware of those secretive processes and formulations that might affect the health and safety of employees. The foundation of the 14 elements, 'management commitment', can also be considered an element of PSM.

Figure 2: 14 Elements of OSHA's process safety management programme (Adapted from Wikipedia, 2018)

A PSM programme should be drawn up by a company team, with all stakeholders represented, and should be tailor made for that company and its business activities. External PSM specialists can be contracted to assist the company team, but should never be allowed to develop a PSM programme on behalf of the company. The company team should be intimately involved to ensure ownership.

Any effective PSM programme comprises four main categories of elements, namely:

- Commitment to process safety;
- Understanding hazards and risks;
- Management of risks; and
- Learning from experience.

Each of these is discussed in turn.

Commitment to Process Safety

Commitment is the first step in ensuring that a culture of process safety is entrenched within a business, and includes the following elements:

- Leadership/Management commitment;
- Accountability/roles and responsibilities;
- Process safety culture;
- Company standards, codes & regulations; and
- Workforce and stakeholder involvement.

Understanding Hazards and Risks

Understanding hazards and risks covers the systems and information required to analyse and understand the risk and type of potential hazards in a business. It potentially includes the following elements:

- Process knowledge management;
- Process safety information;
- Inherently safer design;
- Process hazard analysis;
- Risk analysis; and
- Capital project review.

Management of Risks

Management of risks includes all activities, processes and systems required to manage the identified potential hazards in a business.

Examples of these elements are:

- Pre-Startup Safety Review for new facilities;
- Safe operating procedures and practices;
- Operational readiness testing;
- Management of Change procedures;
- Asset integrity and reliability (maintenance, inspection, testing, QA/QC);
- Training and performance assurance;
- Competence testing (operations, technical and contractor personnel);
- Contractor management; and
- Emergency management.

Learning from Experience

Learning from experience includes all lessons learned from incidents and near misses, and any improvements that are identified during reviews and audits.

Examples of these elements include:

- Incident investigation;
- Sharing of lessons learned;
- Measurement and metrics;
- Compliance audits; and
- Management review and continuous improvement

Concluding remarks

Effective process safety management is highly dependent on the quality of leadership in an organisation and on their commitment to embracing a culture of safety and process safety.

A PSM programme is essential to identify and measure safety activities that should be on the radar for all company employees and stakeholders. Measurement should focus on leading metrics and an integrated set of performance indicators, and frequent audits should probe each element.

Organisational competence should be continuously enhanced (through recruitment and training), and excellent examples of operational discipline should be highlighted and celebrated!

References

Wikipedia, 2018, *Process Safety Management*. Available from https://en.wikipedia.org/wiki/Process_safety_management. Accessed on 29 June 2018.