Process Safety Management: Beyond the Norm

Rizal Harris Wong, Custodian (Process Safety), PETRONAS, Kuala Lumpur Malaysia.

Yogendren Sevakumaran, Principle (Process Safety), PETRONAS, Kuala Lumpur Malaysia.

Mohamad Fazaly Mohamad Ali, Principle (Process Safety), PETRONAS, Kuala Lumpur Malaysia.

Nor Afida Sikandar Bacha, Staff (Process Safety), PETRONAS, Kuala Lumpur Malaysia.

Abstract

Process Safety journey started in the year 2000 and PETRONAS has continually improved on Process Safety Management over the years. In 2020, focus and emphasis was given for the improvement of Process Safety Performance towards achieving Zero Process Safety Event aspiration.

Process Safety Focused Enhancement (PSFE) initiative was established in 2020 as a 3-point strategy to support Zero Process Safety Event aspiration. PSFE is envisioned to focus on specific key areas i.e., Leadership & Accountability, Risk Visibility & Escalation and System Enhancement, which is anticipated to elevate Process Safety excellence throughout the organization.

"PSM System Enhancement" strategy focus on holistically drive & govern Process Safety Management beyond the Process Safety eight (8) aspects. As technology advances, the scale and complexity of the process also increase rapidly, hence it is becoming harder to control accidents in process plants. Based on past incidents, it appears that incidents are no longer controlled solely by engineering practices but should immersed in holistic safety management programs. Operating companies are increasing efforts to reduce the risk of catastrophic events such as the release of toxic, reactive, or explosive chemicals that can damage the environment or plant assets, as well as cause injury or death to employees and the general public.

While functional safety has proven successful in reducing the probability of catastrophic events and recognizes the role of human factors, it does not explicitly address the key roles of management and business processes in maintaining operational integrity and profitable performance of process plants. Process Safety Management entails development and implementation of program or system to prevent catastrophic accidents involving hazardous materials and is key to safe and reliable plants. The system enhancement has divided Process Safety Management into three (3) main cores namely Leadership & Accountability, Risk Visibility & Escalation and System Enhancement. The enhancement focuses on holistically drive and govern Process Safety Management beyond Process Safety 8-Aspects and through interlinkages of multi-disciplinary system. This paper presents the system enhancement based on incident lesson learned.

1. Introduction

Process Safety journey started in PETRONAS in the year 2000 and PETRONAS has continually improved on Process Safety Management (PSM) over the years. In 2020, focus and emphasis was given for the improvement of Process Safety Performance towards achieving Zero Process Safety Event aspiration.

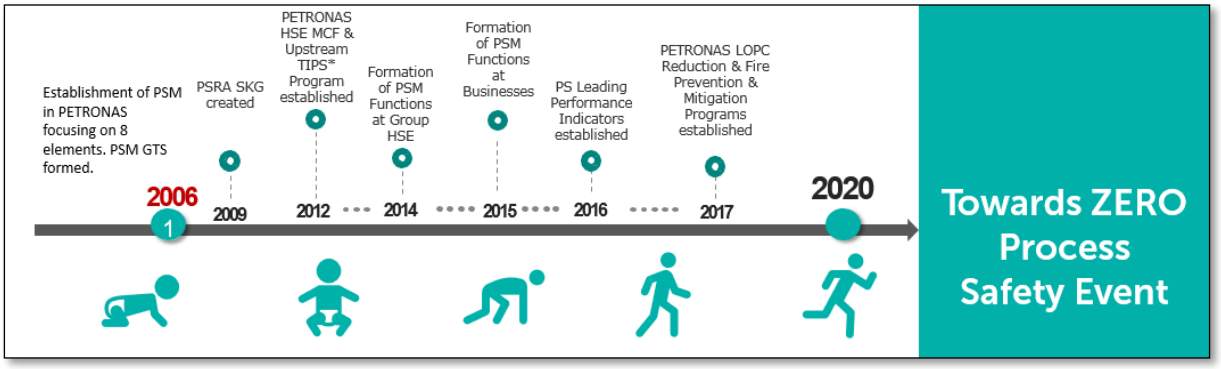

Figure 1: PETRONAS Process Safety Journey

In 2019, record indicates that Major Process Safety Event (PSE) occurrence has suppressed to 50% compared to what we have had in 2015. Similarly, fatality and Loss Time Injury (LTI) are also on a downward trend due to shared success collaboration between all discipline's workforce including Process Safety. However, statistic also indicates that one single Major PSE could cause major impact for PETRONAS as what we have seen happening recently.

Therefore, focus and emphasis was given to the importance of Process Safety by top management. through the establishment of Process Safety Focused Enhancement (PSFE) initiative, which is a 3-point strategy to support the Zero Process Safety Event aspiration. PSFE is envisioned to focus on specific key areas i.e., **Leadership & Accountability**, **Risk Visibility & Escalation** and **System Enhancement**, which is anticipated to elevate Process Safety excellence throughout the organization.

Figure 2: 3-Point Strategy of Process Safety Focused Enhancement (PSFE)

2. Aims

The objective of Process Safety Management (PSM) is to ensure comprehensive, robust, and sustainable system for managing process safety risk and minimizing the likelihood of a major accident. PETRONAS PSM requirements are operationalised mainly through PETRONAS HSE MS, while strongly supported by other PETRONAS Management Systems within PETRONAS Governance Management Framework (PGMF).

"**PSM System Enhancement**" strategy focus on holistically drive & govern Process Safety Management beyond the Process Safety eight (8) aspects. As technology advances, the scale and complexity of the process also increase rapidly, hence it is becoming harder to control accidents in process plants. Based on past incidents, it appears that incidents are no longer controlled solely by engineering practices but a combination of technical and cultural factors which requires a holistic safety management approach. Operating companies are increasing efforts to reduce the risk of catastrophic events such as the release of toxic, reactive, or explosive chemicals that can damage the environment or plant assets, as well as cause injury or death to employees and the general public.

3. Process Safety Elements

3.1 Learning from Incidents

In driving and governing Process Safety Management in PETRONAS, the following **main elements** have been in place and focused upon since the establishment of PSM requirements i.e., Management of Change (MOC), Process Hazard Analysis (PHA), Process Safety Information (PSI), Design Integrity (DI), Mechanical Integrity (MI), Operating Procedure (OP), Pre-Activity Safety Review (PASR) and Proprietary and Licensed Technology Assessment (PLTA).

Improvement in PSM over the years can be reflected through the reduction in the occurrence of Major Process Safety Events (PSE)/ incidents. Incident statistics from the 2015 to 2020, indicates a decreasing trend with respect to number of Major PSE/ incidents occurrence across the organization. However, based on the outcome of incident investigations conducted over the years, repeated findings of inadequate PSM system performance were observed, indicating the actual root causes are not addressed.

To understand the causes of our current performance, PETRONAS need to relook at the way we as an organization work in managing process safety risks, create the right ecosystem and elevate the mindset and capability of our frontliners to be conscious of the potential risks related to their day-to-day operations.

Tapping into various process safety related incidents provided valuable insights for this improvement. PETRONAS have adopted deep dive approach on analysing previous incidents, which was found to be coherent. Initial incident investigation focuses mainly on identifying the immediate causes of the incident and does not track back far enough to understand the background stories or events. Deep dive approach analyses the interactions between the various components/ parts of the incident whether they are physical (i.e., installations, organisations, policies, procedures), or cognitive (i.e., norms, practices, organisation) within a particular system.

Table 1 below shows additional insights that were identified during deep dive of the incidents.

Table 1: Learning from Incidents

No.	Incidents	Incident Investigation Findings	Deep Dive Insights
1	Incident #1: Major Fire at refinery resulting in major asset damage	Deficiencies in implementing Management of Change (MOC) and or Pre-Activity Safety Reviews (PASRs) for the changes involving valves replacement.	• **Competency** - Knowledge of personnel on high temperature sulfidation and requirement for use of special material. • **Organization Change** – Critical positions were left vacant for few years. • **Procurement Process** – Understanding and compliance to procurement work process.
2	Incident #2: Major Fire at refinery resulting in major asset damage	Deficiencies in implementing adequate Process Hazard Analysis (PHA) and develop Operating Procedure for 3rd Party Equipment.	• **Procurement & Contractor Management** – Failure to establish a comprehensive contract between supplier and company. • **Safe Operation –** Failure to include essential parameter to be recorded and analysed during daily monitoring. • **Asset Integrity** – No intervention and rectification of any faulty component due to maintenance program of 3rd party equipment.

No.	Incidents	Incident Investigation Findings	Deep Dive Insights
3	Incident #3: Vent piping rupture resulting in a major asset damage (blast impact) and minor LOPC at offshore platform	Deficiencies in implementing Permit to Work (PTW) system during Simultaneous Operations (SIMOPS) activities.	• **Asset Integrity** – No proper preservation of equipment for delayed projects. • **Competency** - Knowledge of personnel in handling SIMOPS activities. • **Organization Change** – Managing availability of critical positions during critical period of project. • **Interfaces** – Clarity of asset ownership (i.e., either project or operations) and work planning.

Ensuring that lessons are learned from previous incidents so that identical or similar accidents arising from work activities can be prevented in the future is central for achieving ZERO Process Safety Event Aspirations as well as to protect people's health and safety by ensuring that risks arising from work activities are properly identified and mitigated. Using these as examples, Integrated Process Safety Management (IPSM) was created to ensure comprehensive, robust, and sustainable system for managing process safety risk and minimizing the likelihood of a major accident

3.2 Integrated Process Safety Management (IPSM)

The key components of PETRONAS PSM requirements can be reflected as per PETRONAS Integrated PSM Model (IPSM), see Figure 3 below. The IPSM is illustrated in spinning circle to imply that Process Safety risk is dynamic, and it has to be consistently managed throughout the asset lifecycle. It covers the necessary requirements that relate to Design, Construct, Operate, Maintain, Decommissioning and Mothball of the assets. It is made up of 17 elements which are clustered into 3 cores.

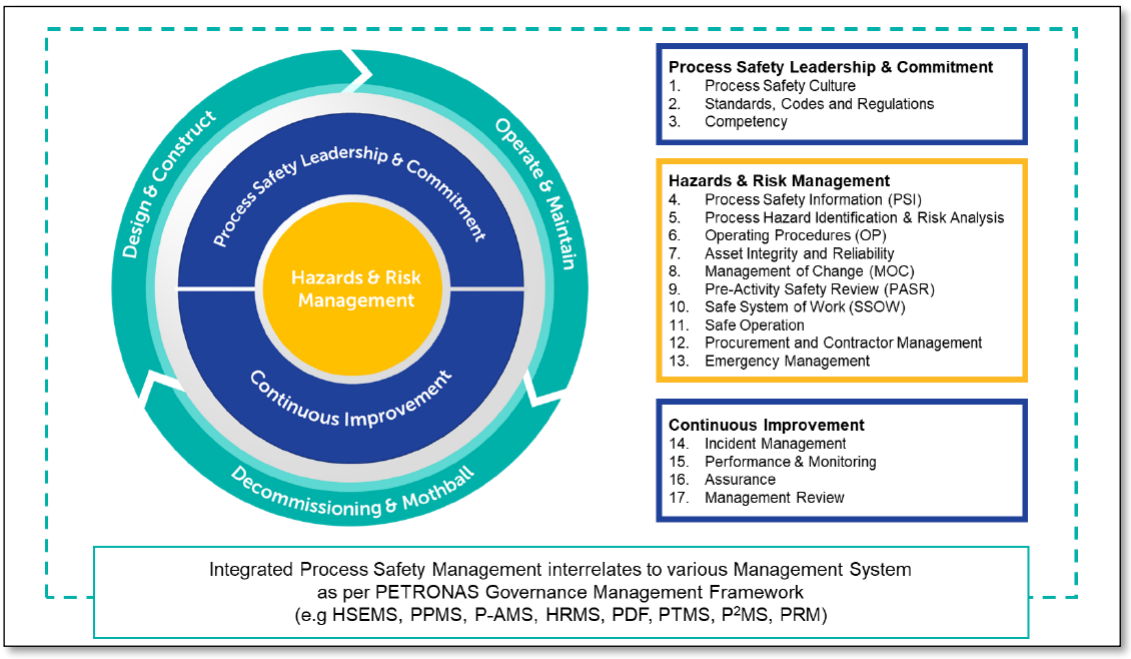

Figure 3: The PETRONAS IPSM Model

The first core is **Process Safety Leadership and Commitment**. Process Safety Leadership and Commitment shall be translated as compliance to the requirements as well as building PS competency in the organization. This core to emphasize that leadership at all levels would drive Process Safety culture that enables us to achieve Process Safety excellence. Strong foundation and culture ensure consistent practice of Core 2 and Core 3.

Table 2: Process Safety Elements under 1st Core

Element		Description
Element 1	Process Safety Culture	To nurture and elevate the maturity of Process Safety culture towards generative.
Element 2	Standards, Codes and Regulations	To identify, develop, evaluate, and provide access to applicable procedures, standards, codes, regulations, and laws that affect Process Safety performance.
Element 3	Competency	To define competency levels of personnel who manage Process Safety risk to possess the essential skills and knowledge and can apply them appropriately in a particular working environment.

At the centre of the circle from the Integrated PSM illustration is the second core i.e., **Hazards & Risk Management**. The ultimate requirement for Process Safety is to identify the hazard and manage the risk accordingly. It is important to identify potential of PS hazards at different stages of assets / key activities and manage the risk to ALARP.

Table 3: Process Safety Elements under 2nd Core

Element		Description
Element 4	Process Safety Information (PSI)	To maintain correct and sufficient information on equipment and systems to allow accurate HSE risks identified and managed. It ensures the required information is maintained and accessible to the required personnel to manage Process Safety risk.
Element 5	Process Hazard Identification and Risk Analysis	To identify and assess the risk associated with process hazards throughout assets lifecycle and make recommendations to ensure risks are managed within tolerable levels.
Element 6	Operating Procedures (OP)	To provide clear procedures and instructions on how to consistently perform operational task activities e.g., start-up, shutdown, etc and ensure the plant/facilities are operated in safe, reliable, and efficient manner.
Element 7	Asset Integrity and Reliability	To ensure equipment is properly designed, installed in accordance with specifications, and remains fit for use until it is decommissioned to prevent LOPC.
Element 8	Management of Change (MOC)	To ensure appropriate level of review is applied to prevent adverse effects from changes. MOC ensures that the integrity of the installation and the impact to people, asset, environment, and reputation is not compromised by adequate evaluation of hazards related to change.
Element 9	Pre-Activity Safety Review (PASR)	To ensure the planned activity is thoroughly reviewed before its commencement to confirm flawless and safe execution of activity.
Element 10	Safe System of Work (SSOW)	To identify and manage process safety risk when the activities are not governed by Operating Procedures which helps control the hazards associated with maintenance and other non-routine work in the assets.
Element 11	Safe Operations	To define how operational and management task are to be executed consistently and effectively with clear accountabilities to ensure operational discipline.
Element 12	Procurement and Contractor Management	To address selection, acquisition, utilization, and monitoring of operational interfaces with customers, supplier, and contractor to ensure safe and effective contract execution with regards to process safety risk e.g., goods receiving, major maintenance activities, turnaround, etc.
Element 13	Emergency Management	To specify mandatory requirements for emergency preparedness, response, and crisis management.

The third core of Integrated PSM is **Continuous Improvement**. The heart of PS Management is the drive towards Zero Process Safety Event. This can be achieved by driving site compliance, analysing current PS performance, and taking actions as part of continuous improvement.

Table 4: Process Safety Elements under 3rd Core

Element		Description
Element 14	Incident Management	To provide process for incident notification, investigation, and reporting in the event of process safety incident. It is important to learn from past mistakes and prevent reoccurrence.
Element 15	Performance and Monitoring	To ensure that process safety risks are being monitored and reported effectively. This element addresses which indicators to consider, how often to collect data, and what analysis to perform for improvement.
Element 16	Assurance	To evaluate whether management systems are performing as intended to ensure Process Safety risk is adequately managed.
Element 17	Management Review	To describe the procedure to plan, conduct and manage Management System Review using Plan-Do-Check-Act (PDCA) cycle. The primary intent is to understand the adequacy, relevancy, and effectiveness of the system in delivering the desired results of the organization.

4. Summary

We need to relook at the way we work in managing process safety risks, create the right ecosystem and elevate the mindset and capability of our frontliners to be conscious of the potential risks related to their day-to-day operations. Process Safety behaviours hence culture contributes to the overall Generative HSE Culture. Programs to instil and sustain the Generative HSE Culture must include Process Safety aspect which has been developed and prescribed in the PETRONAS Integrated Process Safety Management (IPSM).