Singapore’s Approach to Process Safety Management

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A Great Workforce A Great Workplace
1. Development of Process Safety Management

2. Regulatory framework to engender the adoption of Process Safety Management

3. The way forward

4. Concluding Remarks
Process Safety Management

• A holistic management of process safety to prevent process incidents and mitigate their consequences

• The application of management principles and systems to identify, understand and control of process hazards to protect employees, facility assets and the environment.
Development of Process Safety Management

Impetus for the development of Process Safety Management worldwide

Expanding Scale of Operation and Technical Complexity

Major Hazard Incidents In late 80’s

Many authorities worldwide re-examine the Management of Process Safety
Development of Process Safety Management

International Labour Organisation (ILO)

In 1990, ILO convened a meeting of experts at Geneva to draw up a *Code of Practice on the Prevention of Major Industrial Accidents*
Development of Process Safety Management

ILO’s Code of Practice on the Prevention of Major Industrial Accidents

Authorities

• Establish a national major hazard control system
• Determine causes of major industrial accidents

Management

• Provide high standard of safety
• Carry out assessment of hazards and risks
• Ensure safe design and operation
• Train workers to understand processes and hazards involved
• Plan and provide measures to mitigate potential accidents
Development of Process Safety Management

Occupational Safety & Health Administration (OSHA)

- Emphasise the management of hazards associated with highly hazardous chemicals and establishment of a comprehensive management program that integrated technologies, procedures, and management practices
- The standard was enacted as law in USA in 1992
American Petroleum Institute (API)

- In Jan 1990, **API RP 750 "Management of Process Hazards"** was developed for refineries, petrochemical operations, and major processing facilities.

- The Recommended Practice addresses the management of process hazards in design, construction, start-up, operation, inspection, maintenance, and modification of facilities with the potential for catastrophic release.

- The **API RP 750** addresses the management of process hazards through the implementation of elements of control similar to that of OSHA.
Recommended Practice on Process Safety Management

- Ministry of Manpower (MOM), in consultation with the major refineries and the petrochemical plants, established the *Recommended Practice on Process Safety Management* in 1993.

- The Recommended Practice (RP) modeled closely to the OSHA’s 29 CFR Part 1910.119 and API RP 750.

- The objective was intended to eliminate or mitigate the consequences of large accidental releases involving hazardous substances.

- Refineries & petrochemical plants were advised to implement the Recommended Practice on Process Safety Management.
Elements of the Recommended Practice on Process Safety Management (1993)

1. Safety Policy & Work Practices
2. Process Safety Information
3. Process Hazard Analysis
4. Management of Change
5. Operating Procedure
6. Mechanical Integrity
7. Training
8. Pre-start up Review
9. Incident Investigation & General Plant Inspection
10. Emergency Planning & Response
Development of Process Safety Management

A work group comprising MOM and OPITSC* was formed in 2000 to develop a code of practice on safety management system for the chemical industry -

• Consisting 14 elements as stipulated under the Factories Act
• Containing elements for managing **Safety and Health at work**
• Containing elements for managing **Process Safety** to eliminate or mitigate consequences of large release of hazardous substances
• Incorporating elements from the MOM’s **Recommended Practice on Process Safety Management** (1993)

*OPITSC - Oil and Petrochemical Industry Technical & Safety Committee*
# Development of Process Safety Management

**MOM’s Recommended Practice on Process Safety Management System (2001)**

<table>
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<th>Element 1</th>
<th>Safety Policy</th>
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<td>Element 14</td>
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Development of Process Safety Management

MOM’s Code of Practice on Safety Management System for the Chemical Industry (2001)

- Eliminate process incidents or mitigate their consequences
- Prevent work injuries

Management of Process Safety

Management of Occupational safety & health

Code of Practice on Safety Management System
The MOM’s Code of Practice on Safety Management System for the Chemical Industry (2001) was a reference document for mandatory implementing and auditing OSH Management System for the Oil & Petrochemical industries.

Other chemical plants could also make reference to this document for managing Occupational Safety & Health and Process Safety.
Development of Process Safety Management

Singapore Standard SS 506 Part 3

• In 2006, SPRING Singapore launched a national standard on OSH for the Chemical Industry


With this launch, MOM withdrew the *Code of Practice on Safety Management System for the Chemical Industry*
Development of Process Safety Management

**Singapore Standard SS 506 Part 3**

- Develop based on Singapore Standard, SS 506 Part 1’s framework
- SS 506 Part 1 – Specification for Occupational Safety & Health (OSH) Management System (A full adoption of OHSAS 18001)
- Draw technical reference from MOM’s Code of Practice on Safety Management System for Chemical Industry
Development of Process Safety Management

Singapore Standard SS 506 Part 3

Amalgamation of *Process Safety* elements with that of *Occupational Safety and Health* (OSH) and arranged in Plan-Do-Check-Act framework as in SS 506 Part 1 or OHSAS 18001

- Process Safety Elements
- Occupational Safety & Health Elements

Continual Improvement

- Management Review
- OH & S Policy
- Planning
- Implementation & Operation
- Checking and Corrective action
## Development of Process Safety Management

### Breakdown of Elements of SS 506 Part 3

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<th>OSH Policy &amp; Structure Elements</th>
<th>Occupational Health Elements</th>
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<td>4.3.2 Legal and other requirements</td>
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<td>4.3.3 Objectives and targets</td>
<td>4.4.7.2 Hearing conservation</td>
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<td>4.3.1.3 Incident investigation and root cause analysis</td>
<td>4.3.4 OSH management programme(s)</td>
<td>4.4.7.3 Respiratory protection</td>
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<td>4.4.2 Training, awareness and competence</td>
<td>4.4.1.1 Structure, responsibility and authority</td>
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<td>4.4.2 Operating procedures and Safe Work Practices</td>
<td>4.4.1.2 In-house OSH rules and regulations</td>
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<td>4.4.2 Management of change</td>
<td>4.4.3 Consultation and communication</td>
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<td>4.4.5 Control of document</td>
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<td>4.4.6.7 Control of hazardous substances</td>
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<td>4.4.8 Emergency preparedness and response</td>
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<td>4.5.3 Incidents, accidents, nonconformity, corrective action and preventive action</td>
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Singapore Standard SS 506 Part 3

• A systematic way of managing
  • Occupational Safety and Health risks
  • Process Safety

of the chemical industry through Plan-Do-Check-Act cycle

• Reference document for mandatory audit of management of safety and health system in the oil and petrochemical industry

• Could be used for Certification (SS 506 or OHSAS 18001)
Development of Process Safety Management

1993
Recommended Practice on Process Safety Management

2001
Code of Practice on Safety Management System for the Chemical Industry

2006
Singapore Standard SS 506 Part 3

PDCA Format - Certifiable Standard Comprising Process Safety and OSH elements

Process Safety Focused

14-Element format comprising Process Safety and OSH elements
Regulatory Framework to Engender PSM Adoption

Workplace Safety and Health (Registration of Factories) Regulations

- Oil Refineries and Petrochemical Plants
- Bulk Terminals storing toxic or flammable liquid having storage capacity $\geq 5000\text{m}^3$
- Any plant engaged in the manufacture of Fluorine, Chlorine, Hydrogen Fluoride or Carbon Monoxide
- Any plant engaged in the manufacture of synthetic polymers

Intended occupiers of these installations are required to register the premises as factories, subject to conditions that the Commissioner may specify.

Registration is renewal once in every 5 years.
Workplace Safety and Health (Registration of Factories) Regulations

- **Registration Requirements**
  - Quantitative Risk Assessment (QRA)
  - Process Hazard Analysis* (PHA) studies
  - Safety Management System Audit based on SS 506 Part 3

- **Renewal Requirements**
  - Update PHA* once every 5 years

*PHA includes Hazard and Operability Analysis (HAZOP), Failure Modes and Effects Analysis (FMEA) or any equivalent methods.
**Regulatory Framework to Engender PSM Adoption**

**WSH (Safety & Health Management System & Auditing) Regulations**

The following installations are required to implement safety and health management system:

- Oil Refineries and Petrochemical Plants
- Pharmaceutical Plants
- Bulk Terminals storing toxic or flammable liquid having storage capacity $\geq 5000m^3$
- Any plant engaged in the manufacture of Fluorine, Chlorine, Hydrogen Fluoride or Carbon Monoxide
- Any plant engaged in the manufacture of synthetic polymers

**SS 506 Part 3** will be used as a reference document for the Safety & Health Management System and audit conducted once in every 2 years.
The next phase of Process Safety Management –

• Implementing measurement of effectiveness of Process Safety Management

• Tracking, trending, monitoring of process safety performance and intervention
The Way Forward

Measurement of effectiveness of PSM

Europe
• Developing Process Safety, HSE UK (2006)

USA

Australia
### Examples of Measurement Indicators

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<th>Leading Indicator</th>
<th>Lagging Indicator</th>
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<tr>
<td>• % of employees trained in process hazard awareness and risk assessment</td>
<td>• Number of times workplace safety critical tasks are not being carried out safely</td>
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<tr>
<td>• % of safety critical equipment inspections and maintenance completed to schedule</td>
<td>• No. of failures of equipment and piping due to corrosion, wear or damage</td>
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<tr>
<td>• % of work conducted in accordance with permit conditions</td>
<td>• No. of incidents where plant/equipment could be damaged due to failure to control high-risk maintenance activity</td>
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<tr>
<td>• % of functional tests of safety critical instruments and alarms completed to schedule</td>
<td>• no. of safety critical instrumentation/alarms that fail to operate as designed either in use or during testing.</td>
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The Way Forward

**Measurement leads to confidence**

Early warning before **catastrophic failure** - Avoided discovering weaknesses through **costly incidents**

Stopped collecting and reporting performance info which was no longer relevant – **cost savings**

**Benefits of adopting Process Safety Performance Indicators**

Demonstrated the **effectiveness and suitability** of their risk control systems

An **increased assurance** on risk management and protected reputation

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The Way Forward

Monitoring of Process Safety Performance

Companies

• Should establish or adopt a set of process safety performance indicators to monitor their process safety management performance.

Authority

• Could consider monitoring process safety performance of the process industry by requesting key process safety performance indicators from process plants periodically

• Initiate appropriate intervention if the companies show deteriorating trend in their process safety performance
Implementation of Process Safety Performance Indicators

• MOM and Workplace Safety and Health Council (Chemical Industries) Committee have embarked on a project to produce WSH Guidelines on Process Safety Performance Indicators

• The initiative is to help process plants/companies (especially SMEs) to improve process safety performance in Singapore

• MOM has also begun working with a number of chemical companies to pilot the implementation and submission of process safety performance indicators
Concluding Remarks

- Process Safety Management System enables the process industry to manage the process safety in a structured and systematic way.
- Process Safety Performance Indicators (PSPI) help companies to measure and monitor their process safety management performance.
- PSPI can be an avenue for regulating authorities to monitor the process Industry's safety performance and implement appropriate and timely interventions.