Safety Case Implementation in Singapore

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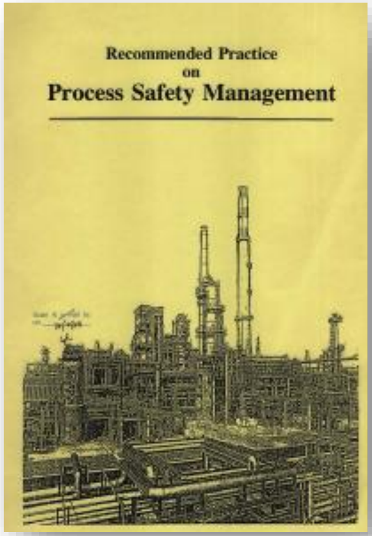
Presentation Outline

1. Background - From Process Safety to Safety Case regime
2. Implementing Safety Case regime
3. Safety Case assessment – key issues and challenges
    - Adequacy of barriers
    - Functional safety
    - Reaction safety
    - EX Equipment
4. Path forward

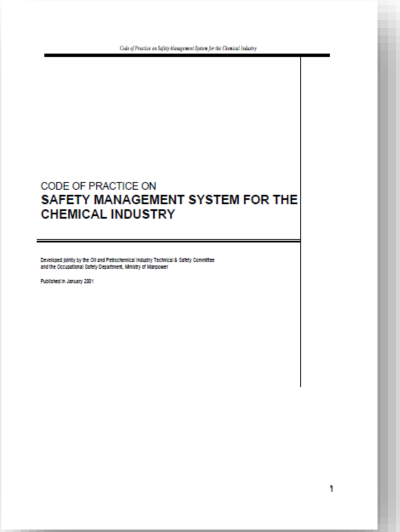
Singapore's Process Safety Management Journey

Modelled after OSHA Rule 1910.119 & API RP 750


Recommended Practice
on
Process Safety Management

1993

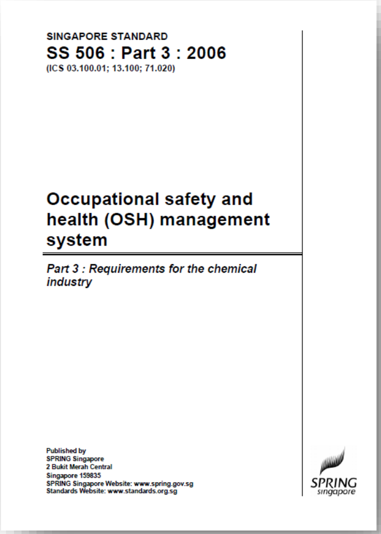
14 elements, with PSM Factories Act Mandatory audits


CODE OF PRACTICE ON
SAFETY MANAGEMENT SYSTEM FOR THE CHEMICAL INDUSTRY

2001

Singapore Standard

SS 506 : Part 3

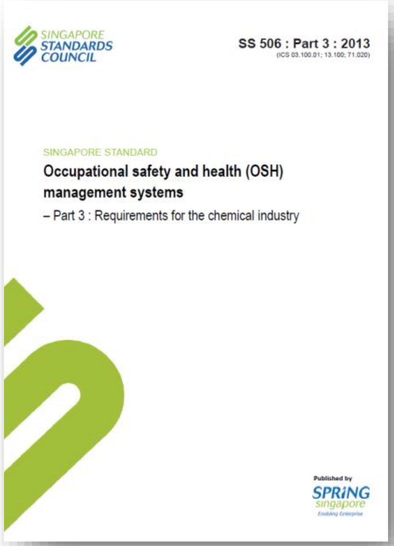

SINGAPORE STANDARD
SS 506 : Part 3 : 2006
(ICS 03.100.01; 13.100; 71.020)

Occupational safety and health (OSH) management system

Part 3 : Requirements for the chemical industry

2006

Revised SS 506 : Part 3


SINGAPORE STANDARDS COUNCIL
SS 506 : Part 3 : 2013

SINGAPORE STANDARD
Occupational safety and health (OSH) management systems
– Part 3 : Requirements for the chemical industry

2013

Shift in Emphasis on Process Safety

- Singapore experienced **process-related incidents** that could potentially escalate into major hazard accidents
- ***Growing number*** of installations in Singapore, coupled with greater process complexity and integration
- Need to address the possibility of ***major hazard accident*** occurrences
- Essential to ***learn from past incidents*** and also from ***best practices*** in other established jurisdictions

Study Mission in 2013

- We believe in learning from past incidents and also from best practices in other jurisdictions

- MOM led a delegation comprising SCDF, NEA, JTC, EDB as well as industry partners, Singapore Chemical Industries Council (SCIC), and Union to study how MHIs were managed in advance countries in Europe in May 2013

- Safety Case is an MHI regulatory tool used in the European Union

Safety Case Regime

- Singapore implemented a Safety Case regime for Major Hazard Installations in 2017
- *WSH (Major Hazard Installations) Regulations*
  - ✓ *Registration of Major Hazard installations*
  - ✓ *Submission and maintenance of Safety Case*
  - ✓ *Notification and reporting of process incidents*
  - ✓ *Sharing of information among designated MHI cluster and affected workplaces*
- A single multi-agency department, the *Major Hazards Department*, for regulatory oversight of the Safety Case regime

WSH (Major Hazard Installations) Regulations

Major Hazard Installations are premises where processing, manufacturing or bulk storage by way of trade or for the purpose of gain is carried on of one or more dangerous substances -

- ✓ *Quantity equals or exceeds the threshold quantity specified in the First Schedule of the Regulations; or*
- ✓ *Aggregate sum of ratios of quantities is equal to or exceeds 1*

$$\frac{q_x}{Q_x} + \frac{q_y}{Q_y} + \ldots + \frac{q_n}{Q_n} + \ldots \geq 1,$$

Examples : *Oil refineries, petrochemical plants and bulk storage terminals*

Factories that do not meet the above definition could be deemed as a MHI, if required, by the Commissioner of WSH

WSH (Major Hazard Installations) Regulations

THIRD SCHEDULE

Purposes of Safety Case

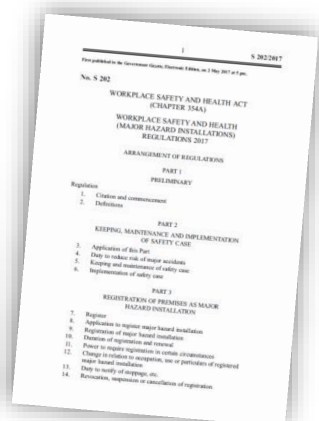
1. To demonstrate that a _major accident prevention policy_ and a _safety & health management system_ have been established and implemented
2. To demonstrate that all _major accident hazards_ have been _identified_ and that
   (a) the _risk of occurrence_ of any major accident has been eliminated; or
   (b) where it is not reasonably practicable to eliminate the risk of a major accident, the risk has been _reduced to as low as is reasonably practicable_ to limit the consequences of an accident
3. To demonstrate that _adequate safety_ and _reliability_ measures, for any installation, equipment or infrastructure connected with the operation of a major hazard installation, in relation to major accident hazards within the major hazard installation have been incorporated into —
   (a) the major hazard installation's _design_ and _construction_; and
   (b) the major hazard installation's _operation_ and _maintenance_
4. To demonstrate that an _emergency response plan_ has been drawn up to take the necessary measures in the event of a major accident

WSH (Major Hazard Installations) Regulations

- WSH(MHI) Regulations is a set of performance-based regulations that provides enabling provisions to implement the Safety Case regime

- The Safety Case regime is a **<u>demonstration</u>** regime - *Major Hazard Installations to showcase to the regulator through a Safety Case*

- Demonstration is by *structured argument*, supported by *a body of evidence*, to provide compelling, comprehensive and valid case that the installation is safe for given application in a given operating environment



1 S 202/2017

No. S 202

WORKPLACE SAFETY AND HEALTH ACT
(CHAPTER 354A)

WORKPLACE SAFETY AND HEALTH
(MAJOR HAZARD INSTALLATIONS)
REGULATIONS 2017

ARRANGEMENT OF REGULATIONS

PART 1

PRELIMINARY

Regulation

1. Citation and commencement
2. Definitions

PART 2

KEEPING, MAINTENANCE AND IMPLEMENTATION OF SAFETY CASE

3. Application of this Part
4. Duty to reduce risk of major accidents
5. Keeping and maintenance of safety case
6. Implementation of safety case

PART 3

REGISTRATION OF PREMISES AS MAJOR HAZARD INSTALLATION

7. Register
8. Application to register major hazard installation
9. Registration of major hazard installation
10. Duration of registration and renewal
11. Power to require registration in certain circumstances
12. Change in relation to occupation, use or particulars of registered major hazard installation
13. Duty to notify of stoppage, etc.
14. Revocation, suspension or cancellation of registration

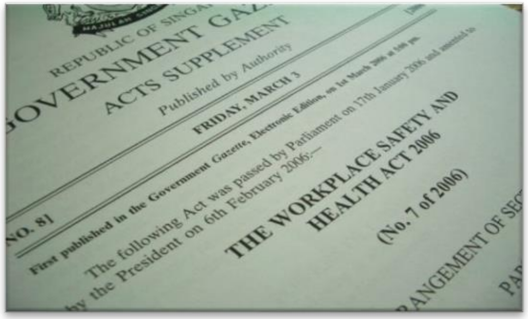
- *Argument without Evidence is **<u>Unfounded</u>***
- *Evidence without Argument is **<u>Unexplained</u>***

Drive Continuous Improvement through ALARP Demonstration

- Safety Case regime is supported by the ***Workplace Safety and Health Act*** that imposes a general duty of care to reduce risk to ***As Low As Reasonably Practicable*** (ALARP)

- The general duties is to do whatever is ***reasonably practicable*** to identify and control all hazards

- Safety Case regime drives MHIs towards managing risk to ALARP instead of mere compliance



Guidance on Safety Case Implementation

Safety Case Technical Guide

Descriptive
Info about MHI

MAPP & SHMS
Focus: major accident prevention

Predictive
Identify major accident hazards & quantify risks

Process Safety

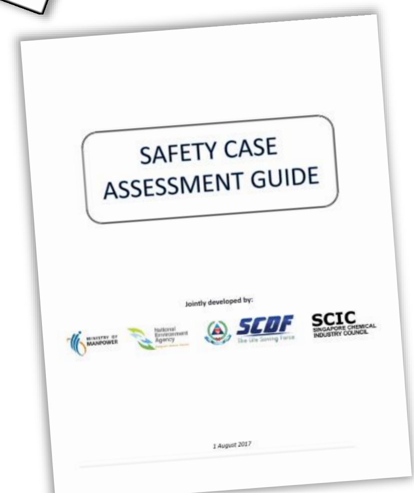
Mechanical Integrity & Assurance

Electrical, Control & Instrumentation

Human Factors
Safety critical task, roles and design

Emergency Response
Incorporating domino impacts

ALARP
Gap analysis & Demonstration

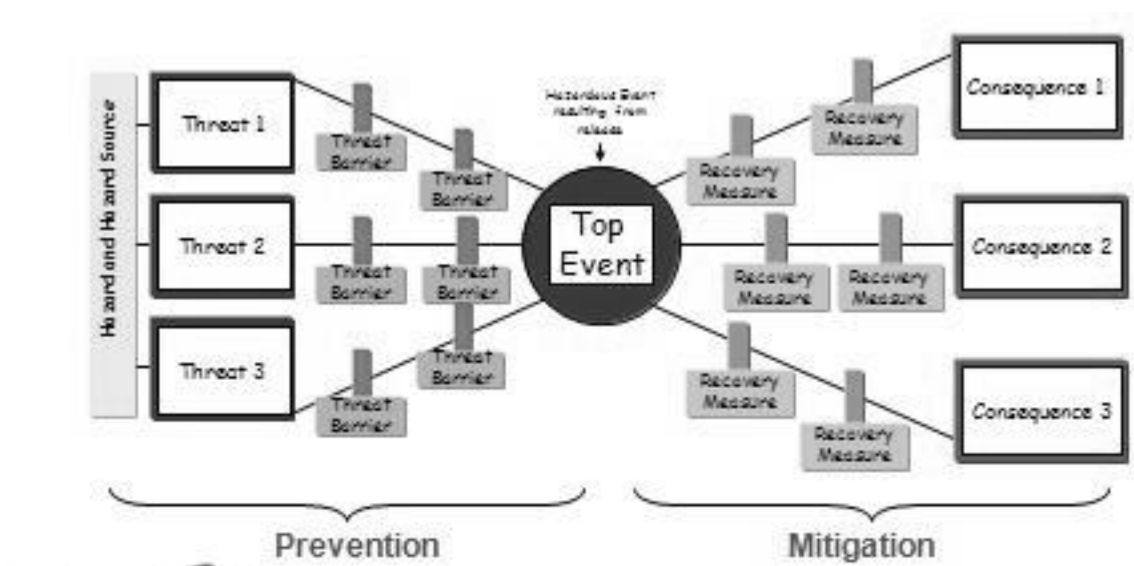


Safety Case Assessment – *key issues and challenges*

Link between Control Measures and SCEs

Safety Case requires MHIs to

- Establish *clear link* between *barriers* (measures) and the *Safety Critical Events* (SCEs)
- Demonstrate how each measure contributes to making the risk to as low as reasonably practicable (ALARP)



Safety Case Implementation

- Completed Safety Case Assessments of MHIs in Phases 0 and 1; currently assessing those in Phase 2

- Key scope of assessment
  - **Adequacy** - Sufficient layers to reduce risk against a set criteria
  - **Robustness** - Gaps are minimised or eliminated to prevent abnormal event

Challenges in Safety Case Assessment

Major Hazard Installations were built in different eras

- Variance in technologies adopted and standards used
- Types of measures or defences deployed against the major accident hazards are dependent on the state-of-the-art of technology available at the point of time

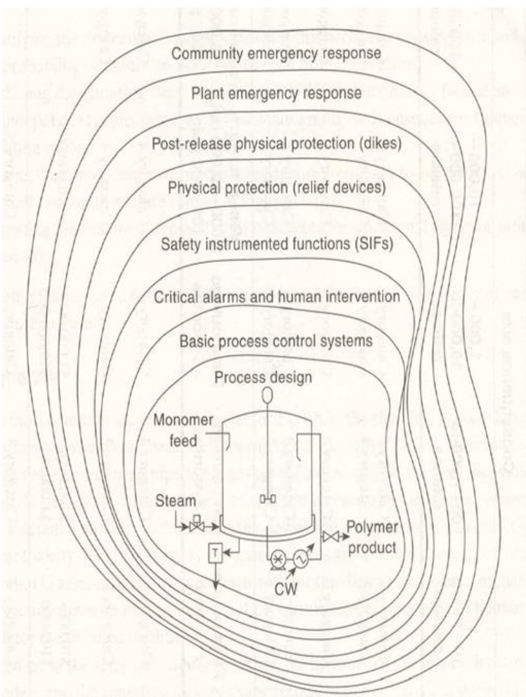
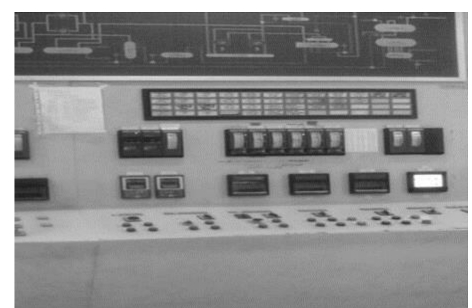


Figure 1: A typical 1990s graphic screen based on a P&ID



Safety Case Assessment - General Observations

Positive observations

- Good understanding of Safety Case Assessment criteria
- High level of understanding of plant operations
- Safety Management Systems in place to manage process safety

Common Gaps Observed

- Insufficient information to make necessary demonstration
- Lack of supporting documents to substantiate demonstration
- High reliance on corporate for control measures adopted, without fully understanding the design basis

Safety Case Assessment

1. Adequacy of Barriers

Expectation	Adequate, independent, effective barriers assessed against a set of risk criteria (corporate/organisation)

Demonstration Shortfalls

1. Inadequate link of control measures (barriers) to the major accidents (the Safety Critical Events)
2. Lack of tolerable risk criteria for major accidents
3. Independence and effectiveness of barriers not well adequately demonstrated

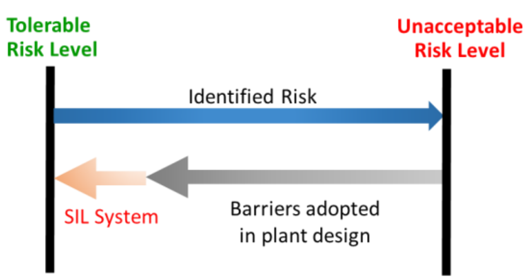
   → Unrealistic credits taken for various barriers

(*Without a systematic approach, outputs can be judgemental and could lead to a false sense of assurance that barriers are sufficient*)

Safety Case Assessment

2. Functional Safety

Expectation	Robust & reliable **Safety Instrumented System** (SIS)/ interlocks assessed by competent personnel
Demonstration shortfalls	1. Lack a systematic approach to identify the need for SIS (e.g. through LOPA) 2. Inadequate robust system to manage design, maintain and operate SIS as an effective barrier: • Knowledge of SIS requirements • SIS Validation and modifications 3. Need to build competency in Functional Safety



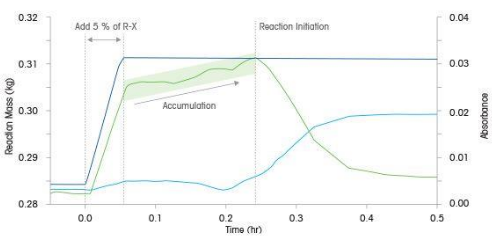
Safety Case Assessment

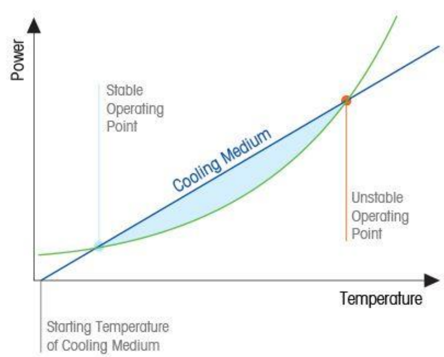
3. Management of EX equipment

Expectation	Effective system to inspect, maintain EX equipment by qualified personnel
Demonstration shortfalls	1. Need to improve integrity assurance relating to maintenance of EX equipment as an effective barrier 2. Need to improve understanding of principles of explosion protection

4. Chemical Reaction Hazards

Expectation	1. Adequate understanding of chemical reactions for safe operations 2. Adequate and reliable control measures in place to prevent against excursions beyond design conditions
Demonstration shortfalls	1. Lack documentation (eg calorimetry studies) due to legacy or proprietary technology resulted in a lack of <u>full</u> understanding by operating team 2. Lack of oversight of other side reactions 3. Unwarranted use of literature where the reaction conditions might differ





Path Forward

Set reasonable expectations between MHIs and MHD

- Establish reasonable timelines to resolve gaps identified and implementation of any action plans
- Address issues during Intervention Plan years
- Continuous 2-way communication between MHI and MHD

MHD will work with the Singapore Chemical Industry Council

- to establish roadmap to improve common industry gaps identified
- to raise industry competency levels



Thank You!