Major Hazards Symposium

Organised by:

Participating Organisations:

Safety Case Regime

Er. Go Heng Huat
Director
Major Hazards Department
Occupational Safety and Health Division
MOM

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Outline of Keynote

- Introduction
- Development of Safety Case regime
- Operationalise Safety Case regime
- Support for Safety Case regime
- Closing remarks

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Introduction

Chemicals sector (Petroleum, Petrochemicals, Specialty Chemicals) is a key contributor to Singapore's economy

Generated S$66 billion in 2016's manufacturing output, maintaining Singapore's status as one of the **world's leading energy** and **chemical hubs**

It is important to ensure that the sector continues to operate in a **safe**, **productive** and **sustainable** manner

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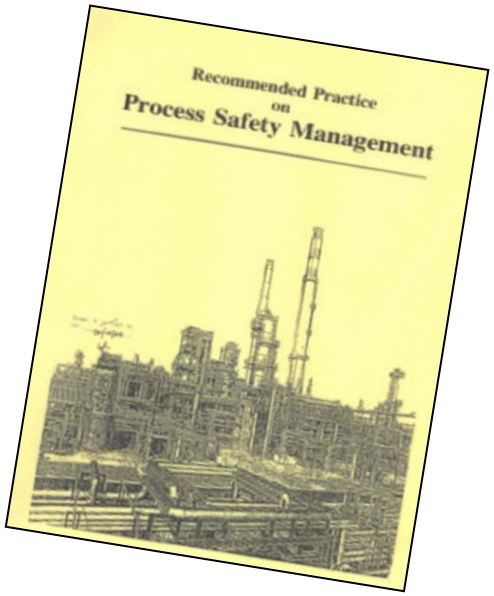
Safety Initiatives in 90s

Singapore embarked on ***Process Safety Management*** (PSM) regime in 90s following the lead of US OSHA Rule 1900.119

Major Hazard Incidents in late 80's

Expanding Scale of Operation and Technical Complexity

Authorities worldwide re-examine the **Management of Process Safety**



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Industry's Response to PSM Initiative

"Please be assured of the commitment and effort put to PSM by member companies in OPITSC Sub-Group"

Chairman, OPITSC

"I take this opportunity to thank and commend the Ministry for its far sighted efforts to promote and enhance process safety management in Singapore"

"… supports the introduction of the "Recommended Practice on Process Safety Management" issued by the Ministry of Labour"

"… the Recommended Practice issued by the MOL as being wholly consistent with our drive for continuous improvement towards excellent in this area"

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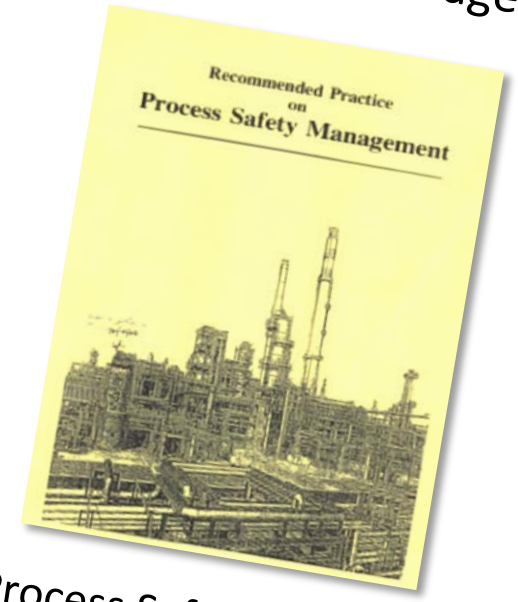
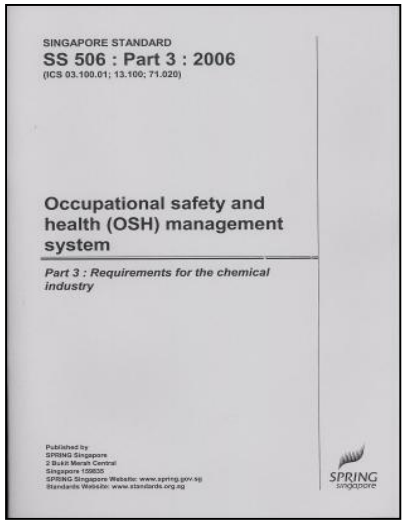
Process Safety Management

1993
Recommended Practice on Process Safety Management



Process Safety Focused

Singapore Standard
SS 506 Part 3



Certifiable Standard
Comprising Process Safety & OSH elements

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Other Key Initiatives

Quantitative Risk Assessment (QRA) in 1995

- ✓ Identify major hazards and quantify the risks
- ✓ Land use planning and emergency planning
- ✓ Recommend practical measures to reduce the hazards and risks

Regulatory framework to engender adoption of PSM

- Workplace Safety and Health (Registration of Factories) Regulations, 2008
- WSH (Safety & Health Management System & Auditing) Regulations, 2009

Process Safety Performance Indicators in 2012
Leading & Lagging Indicators for Process Safety

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Development of Safety Case Regime

Why is there a need to change ?

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Why is there a need to change?

Worldwide

In 2000s, we saw a series of major hazards accidents with *catastrophic consequences*

Local

We also experienced some process-related incidents that could potentially escalate into *major hazard accidents*

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Our Concerns and Challenges

- Realisation of potential **major hazard accidents** could not be ignored
- Growing number of installations in Singapore, coupled with greater process complexity and integration
- There is a need for the MHI sector to place greater emphasis on prevention of **catastrophic major hazard accidents**

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Safety Case Learning Journey

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

- MOM, SCDF, NEA, JTC, EDB as well as industry partners, Singapore Chemical Industries Council (SCIC), and Union embarked on a study mission to learn about how MHIs are managed in Europe in May 2013

- Safety Case is an MHI regulatory tool used in the **European Union –** *the United Kingdom*, *Germany and the Netherlands*

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MHI Study Mission – May 2013

Visited ***Germany***, ***Netherlands*** and ***United Kingdom*** to study how these countries manage MHIs

Competent Authorities (CAs) co-ordinate efforts to manage risks posed by MHIs

Safety Case integrates SHE* protocols to demonstrate to authorities how risks are managed to ALARP

CAs are better able to identify gaps and monitor potential **domino effects** within MHI clusters

Key Recommendations:

1. Better ***coordination*** among regulating agencies
2. Better ***integration*** of safety protocols/requirements at MHI level e.g. safety case
3. Better management of ***domino*** effect risks
4. Enhanced ***capability building*** initiatives for regulators /industry
5. Structured process to ***share lessons*** learnt from MHI incidents

MINISTRY OF MANPOWER
National Environment Agency
SCDF The Life Saving Force
EDB singapore
jtc Breaking New Ground
SCIC SINGAPORE CHEMICAL INDUSTRY COUNCIL
WSHCOUNCIL

* Safety, Health and Environment

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Formation of Inter-Agency Taskforce

An **Inter-Agency Taskforce** was set up in Mar 2014, to review and enhance existing regulatory framework for MHIs to be in line with international best practices

Inter-Agency Taskforce for Major Hazard Installations

Chaired by **MOM**
with Director-Level representatives from
MEWR, **MHA**, **MOM**, **MTI**, **NEA**, **SCDF, EDB** & **JTC**

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Announcement at Budget 2015

Committee of Supply Debate

MOM announced in Parliament (9 Mar 2015) the following:

Managing Major Hazard Installations (MHIs)

MOM will adopt a ***Safety Case regime*** where MHI Operators will need to integrate all their Safety, Health and Environment protocols onsite, and demonstrate to regulators that they have managed their risks to as low as reasonably practicable.

We will introduce a set of **MHI Regulations** under the Workplace Safety and Health Act to effect the Safety Case regime.

A ***National MHI Regulatory Office*** will be set up in 2016 to better coordinate Safety Case assessments, inspections and investigations.

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Formation of Major Hazards Department (MHD)

Roles of MHD

National Environment Agency | MINISTRY OF MANPOWER | SCDF The Life Saving Force

- Single front, jointly regulated by MOM (lead), NEA & SCDF was set up in Sep 2016
- Oversee SHE matters in MHIs
- Receive and assess Safety Cases
- Conduct onsite verification of Safety Cases
- Investigate MHI incidents
- Engage and outreach to MHIs
- Plan and coordinate multi-agency work, including QRA submissions

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WSH (Major Hazard Installations) Regulations

- **Gazette** was published on **2 May 2017** and will come into operation on **1 Sep 2017**
- **Performance-based** regulations that provide **enabling provisions** for operationalising safety case regime
- **Key features** :
  - ✓ Registration of MHIs
  - ✓ Submission and maintenance of Safety Case
  - ✓ Reporting of process incidents
  - ✓ Sharing of information

No. S 202 S 202/2017

WORKPLACE SAFETY AND HEALTH ACT
(CHAPTER 354A)

WORKPLACE SAFETY AND HEALTH
(MAJOR HAZARD INSTALLATIONS)
REGULATIONS 2017

ARRANGEMENT OF REGULATIONS

PART 1
PRELIMINARY

PART 2
KEEPING, MAINTENANCE AND IMPLEMENTATION OF SAFETY CASE

PART 3
REGISTRATION OF PREMISES AS MAJOR HAZARD INSTALLATION

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What is a Safety Case?

A Safety Case regime is a **Demonstration** regime – Onus for **Operators** to showcase to the **Regulator**

A Safety Case **is structured argument,** supported by a **body of evident**, that provides a compelling, comprehensive and valid case that the MHI is safe for given application in a given operating environment

- Argument without Evidence is **Unfounded**
- Evidence without Argument is **Unexplained**

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Safety Case – Overview

- Systematically identify major potential incidents, assess their possible consequences and likelihood
- **Demonstrate** by MHIs that they have put in place appropriate control measures as well as the appropriate emergency procedures.
- **Improved MHI's understanding** of overall hazards and risks, hence enhancing their ability to **better manage risks** arising from major accident hazards.

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WSH (Major Hazard Installations) Regulations

PURPOSES OF SAFETY CASE

THIRD SCHEDULE PART 1

1. To **demonstrate** that a ***major accident prevention policy*** and a ***safety and 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

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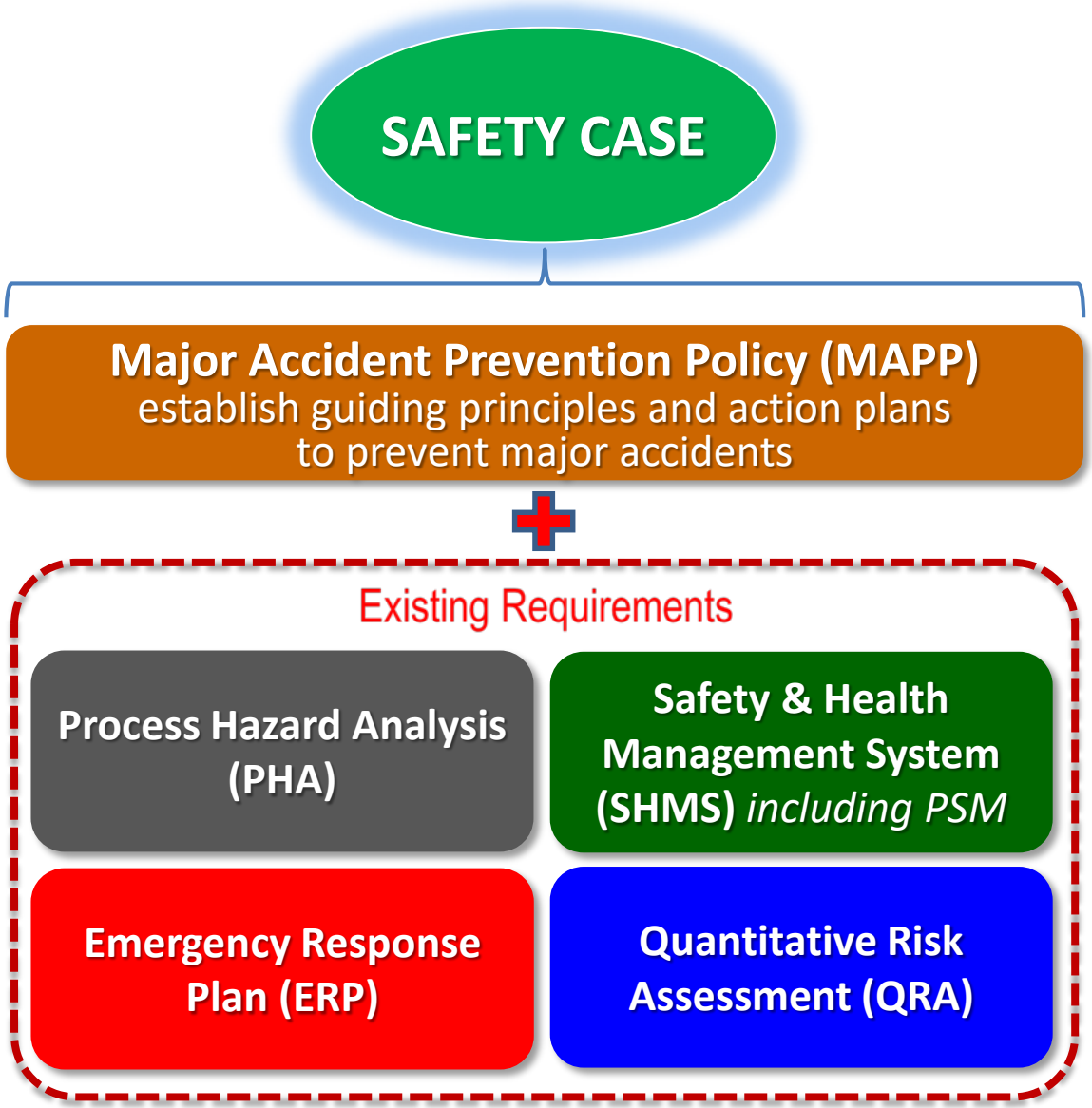
Safety Case Regime – Overview



- A single consolidated Safety Case and a **Live Document**
- **ALARP demonstration**
- Integrate & demonstrate robustness of all SHE protocols to regulators
- Sharing of domino information with neighbouring plants

* *ALARP: As Low As Reasonably Practicable*

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Safety Case – Technical Scopes

Descriptive Info about MHI	**MAPP & SHMS** Focus on Major accidents	**Predictive** Identification of Major accidents & Risk Assessment
Process Safety	**Mechanical Engineering**	**Electrical, Control & Instrumentation**
Human Factors Safety critical task, roles and design	**Emergency Response** Incorporating domino impacts	**ALARP** Gap analysis & Demonstration

Entire MHI lifecycle

(Design, Commission, Operations, Maintenance Decommission)

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Support for Safety Case Regime

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Collaboration with Industry Partners

Formation of Safety Case Joint Government- Industry Work Group

- Develop **Technical Guide** and **Assessment Guide** to support the Safety Case regime
- Develop strategy to build **industry capability** in implementing Safety Case

SCIC
SINGAPORE CHEMICAL INDUSTRY COUNCIL

National Environment Agency

SCDF
The Life Saving Force

MINISTRY OF MANPOWER

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Safety Case Capability Building Timeline

Safety Case training providers
for SC Leads and MHI personnel preparing Safety Cases

Safety Case Practitioners' Workshop

Leadership Forum

Knowledge-Building

Workshop for SC Leads &
MHI personnel preparing SC

Awareness

Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
2016				2017			

Safety Case Clinics

Safety Case Dialogue with Consultants

- Curriculum Development Advisory (CDA) for Safety Case Practitioners' Workshop

Building Competency of Regulator

HSE
Health & Safety Executive

Success of safety case regime hinges on the **competent of inspectors**, their ability to assess a Safety Case objectively

Attachment to HSE in United Kingdom

Attachment of MHD Officers to UK Health and Safety Executive (HSE)

- MHD Officers shadowed HSE inspectors and specialists for onsite safety case assessment & verification
- Observation of safety case demonstrations by MHIs and the resolution process leading to acceptance of safety case

Training

- Technical Training – Process safety, Functional Safety etc
- Training on assessment of key components of safety case

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Professional Engineer (Chemical)

Creation of PE (Chemical) Scheme through PE Board

Important to have a sufficient pool of qualified chemical engineers to support the safety case regime

PE (Chem) can play a key role in process design and in the application of chemical engineering process safety techniques to support the preparation f the safety case

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Research Support to Safety Case Regime

Collaboration with Research Institutes to support Safety Case Regime

- Build research capability to support the Safety Case regime
- Collaboration with **WSH Institute**, **Institute of Chemical Engineering Sciences** (ICES) and **UK Health and Safety Laboratory** (HSL) on research and development of solutions to support Safety Case regime

HEALTH & SAFETY LABORATORY

A*STAR Institute of Chemical and Engineering Sciences

WSH Institute

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Enhancing Process Safety Research

- WSHI-ICES MOU (20 Oct 2016) to provide a framework for collaboration to advance research in the area of **Process Safety**
- ICES to provide specialist support in:
  - Subject matter expertise
  - R&D into process safety and related OSH studies
  - Technical training
- MOM and ICES is working to set up a research-active **Centre of Excellence** to address the needs of the process industry

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Summary

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Concluding Remark

- Through safety case preparation, MHIs improve understanding of overall hazards and risks, hence enhancing ability to better manage risks from major accident hazards.
- Safety Case allows MHIs **flexibility** to showcase ALARP demonstration and better management of domino effects
- Safety case integrates SHE protocols and allows regulators to come together as **one single front** to have better oversight and efficiency in the management of MHIs.
- Potential for harmonising and streamlining of the existing requirements of among regulators, SCDF, NEA and MOM over time.

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Concluding Remark

- Ownership of the Safety Case, must reside with MHIs and therefore it is important to enhance industry's Safety Case capabilities
- Allocation of proper resources towards preparation and implementation of the Safety Case
- The resources allocated should be seen as an investment for continual and sustainable safe operation of the MHIs.

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Petrochemical Corporation of Singapore (Private) Limited

Process Safety in Respect to Business Continuity

Er. Lucas NG HK
General Manager of Plant

Major Hazards Symposium 2017
28 July 2017, SIT@Dover – Academic Plaza, LT1A, 10 Dover Road, S138683

Process Safety in Respect to Business Continuity

1. Introduction
2. Business Continuity Plan
3. Process Safety Perspective on Biz Continuity
4. Crisis Management Plans
5. Emergency Response Plans
6. Conclusion and Takeaway

Process Safety in Respect to Business Continuity

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1. Introduction

Upstream company of Singapore Petrochemical Complex on Jurong Island

1977 – incorporation

supply high quality ethylene, propylene, acetylene, butadiene, 1-butene, MTBE and benzene to companies within Island

1984 – first ethylene plant (cracker) in Southeast Asia on stream

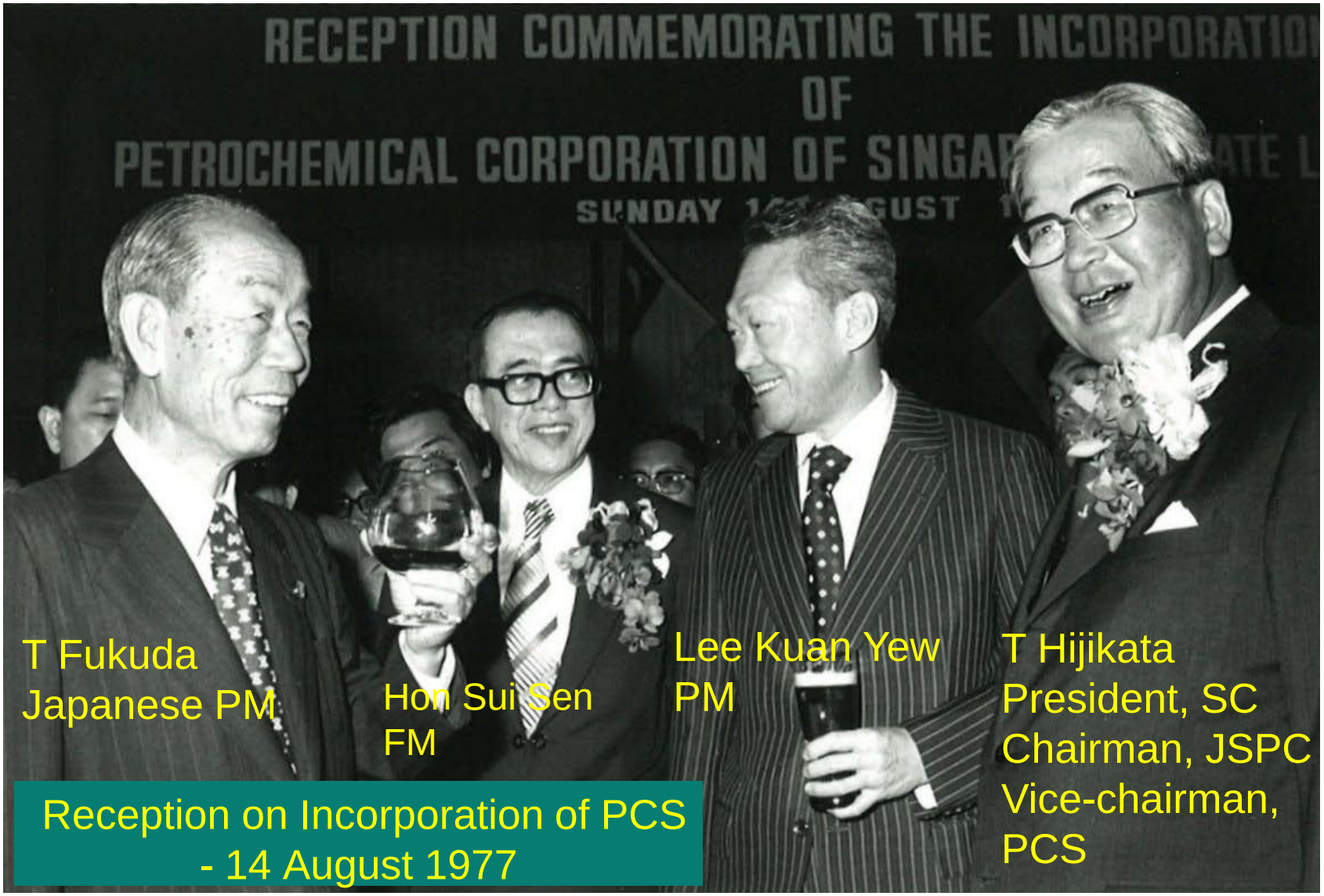
1997 – second cracker unit on stream

Present shareholders

Japan-Singapore Petrochemicals Co., Ltd (50%) (JSPC led by Sumitomo Chemical)
QPI and Shell Petrochemicals (Singapore) Pte Ltd (50%) [*QPI: Qatar Petroleum International]

Source: PCS

Incorporation of PCS – 10 August 1977



Reception on Incorporation of PCS - 14 August 1977

Source: PCS

PCS 1st Ethylene Plant Start-up – 18 February 1984

Source: PCS

First PM Mr Lee Kuan Yew visited PCS – 13 January 2001

Mr & Mrs Lee visited PCS Central Control Centre accompanied by government officials

Source: PCS

1. Introduction

Jurong Island

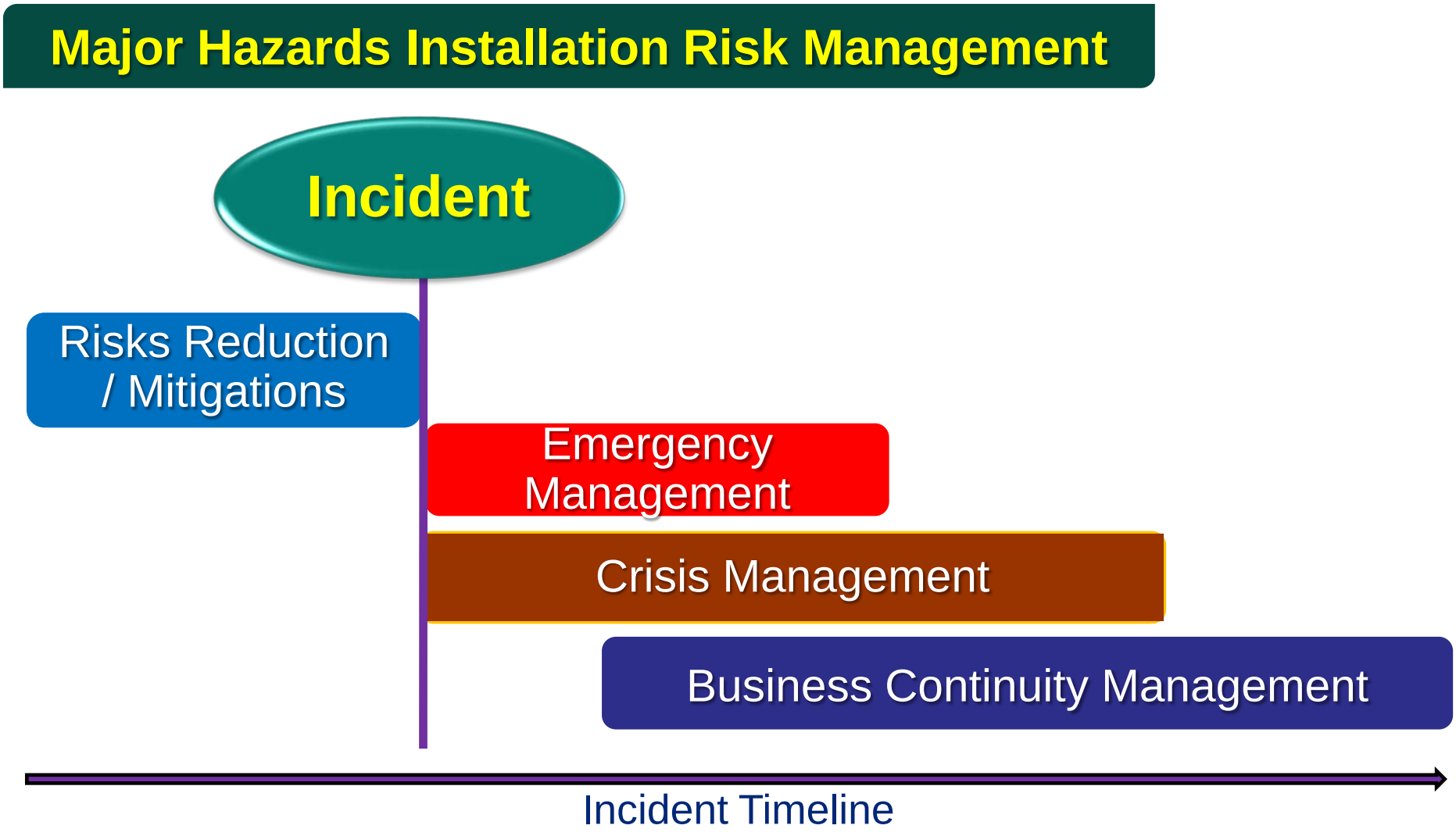
Jurong Island

Petrochemical Corporation of Singapore (Private) Limited, PCS

Source: websites

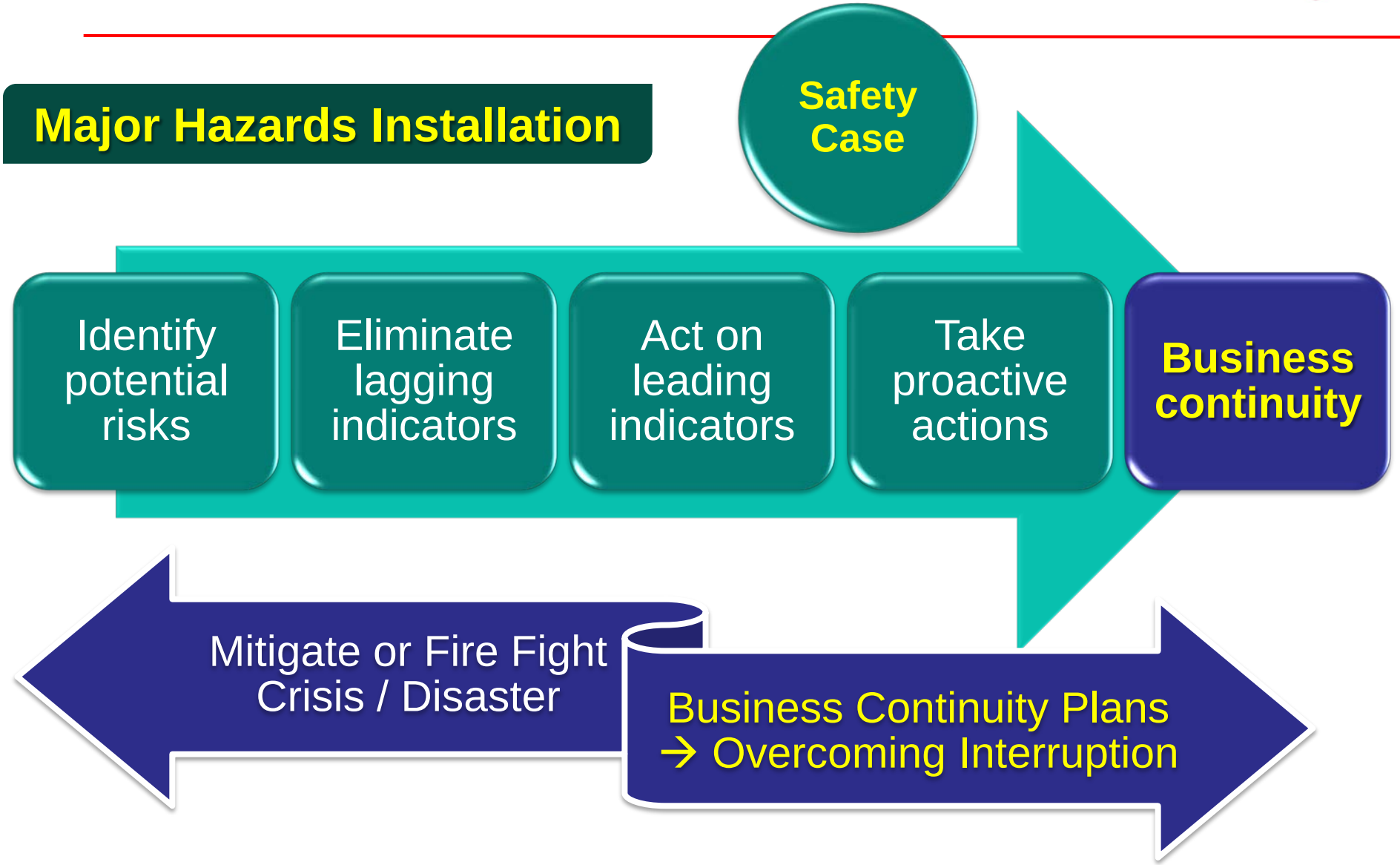
1. Introduction

1. Introduction



1. Introduction

Major Hazards Installation



Process Safety in Respect to Business Continuity

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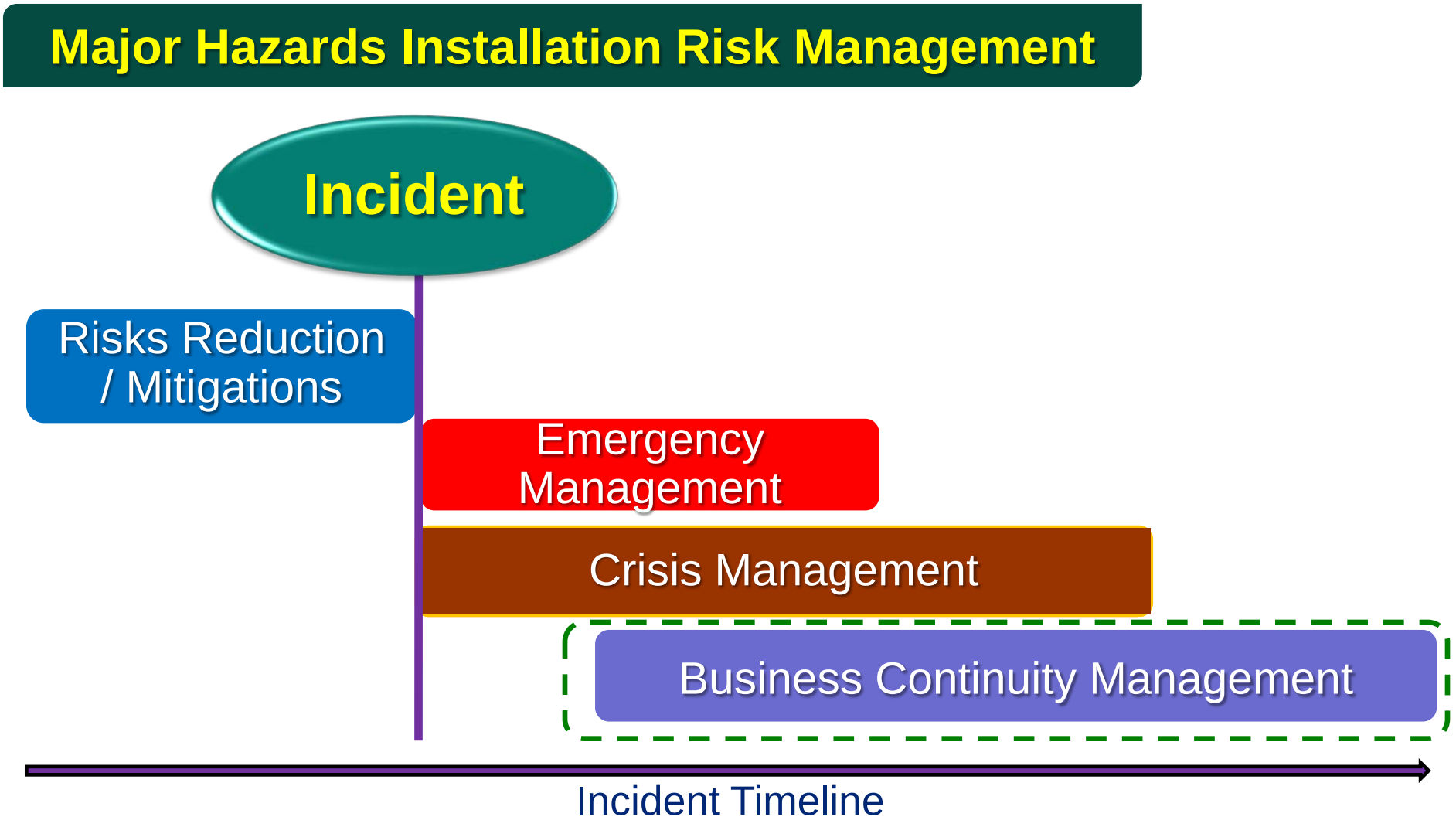
2. Business Continuity Plan



2. Business Continuity Plan

Leading Aspects – Loss Prevention Components

Biz Continuity Planning is NOT a rocket science…

2. Business Continuity Plan

Biz Continuity Planning….

It is a process to

- minimize impact of major disruption to normal operations
- enable restoration of critical assets
- restore normalcy as soon as possible after a crisis

It is just

- essential from process safety perspective
- recovery of information technology resources due to crisis

Leading approach by process safety management → eliminate lagging components

Process Safety in Respect to Business Continuity

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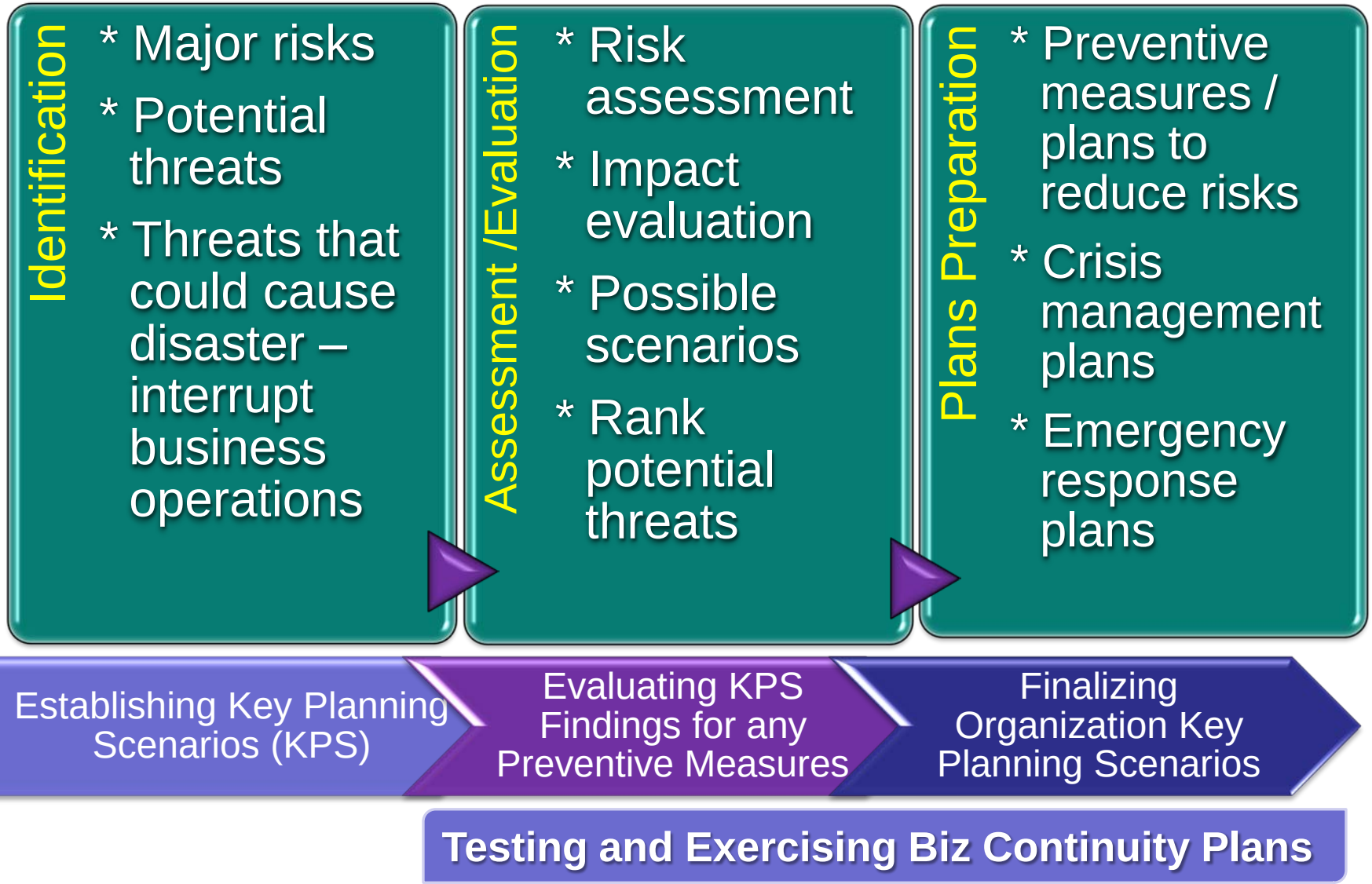
3. Process Safety Perspective on Biz Continuity

Singapore Standard SS504:2008 : Biz Continuity Management (BCM)

For protection of Critical Assets, Human, Environment; Intangible, Physical

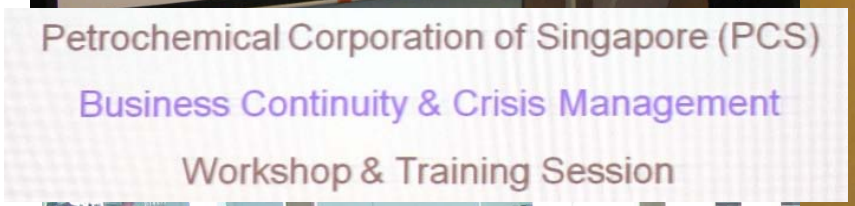
- Provide frame work for organization – analyse and implement BCM system
- Enable organization to develop process & procedures – policy commitments
- Competency development
- Monitor, review performance for continuous improvement

3. Process Safety Perspective on Biz Continuity



3. Process Safety Perspective on Biz Continuity

Training Workshop on Biz Continuity Plans

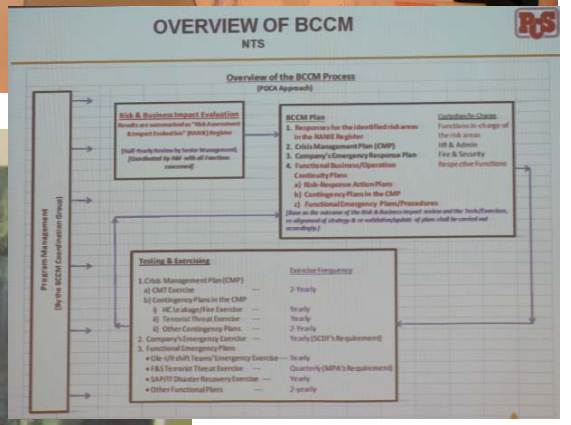


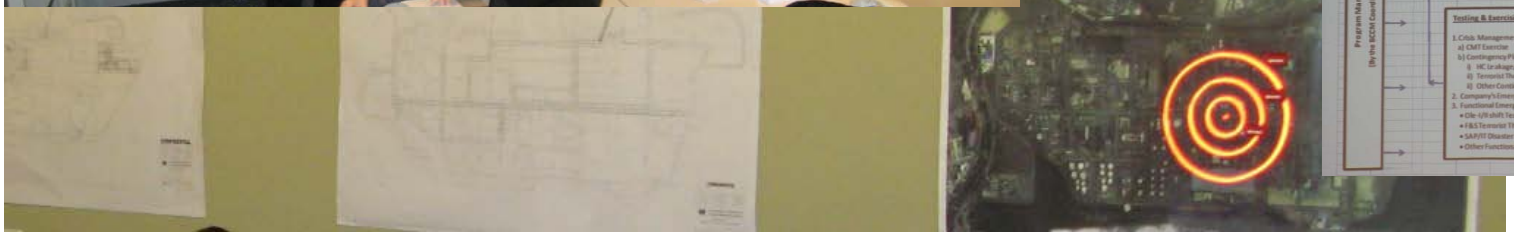
Source: PCS

3. Process Safety Perspective on Biz Continuity

Testing and Exercising Biz Continuity Plans

1300 ~ 1500 hrs	Tabletop exercise	M5
1500 ~ 1515 hrs	Tea Break	M6
1515 ~ 1700 hrs	Tabletop exercise	M5





Source: PCS

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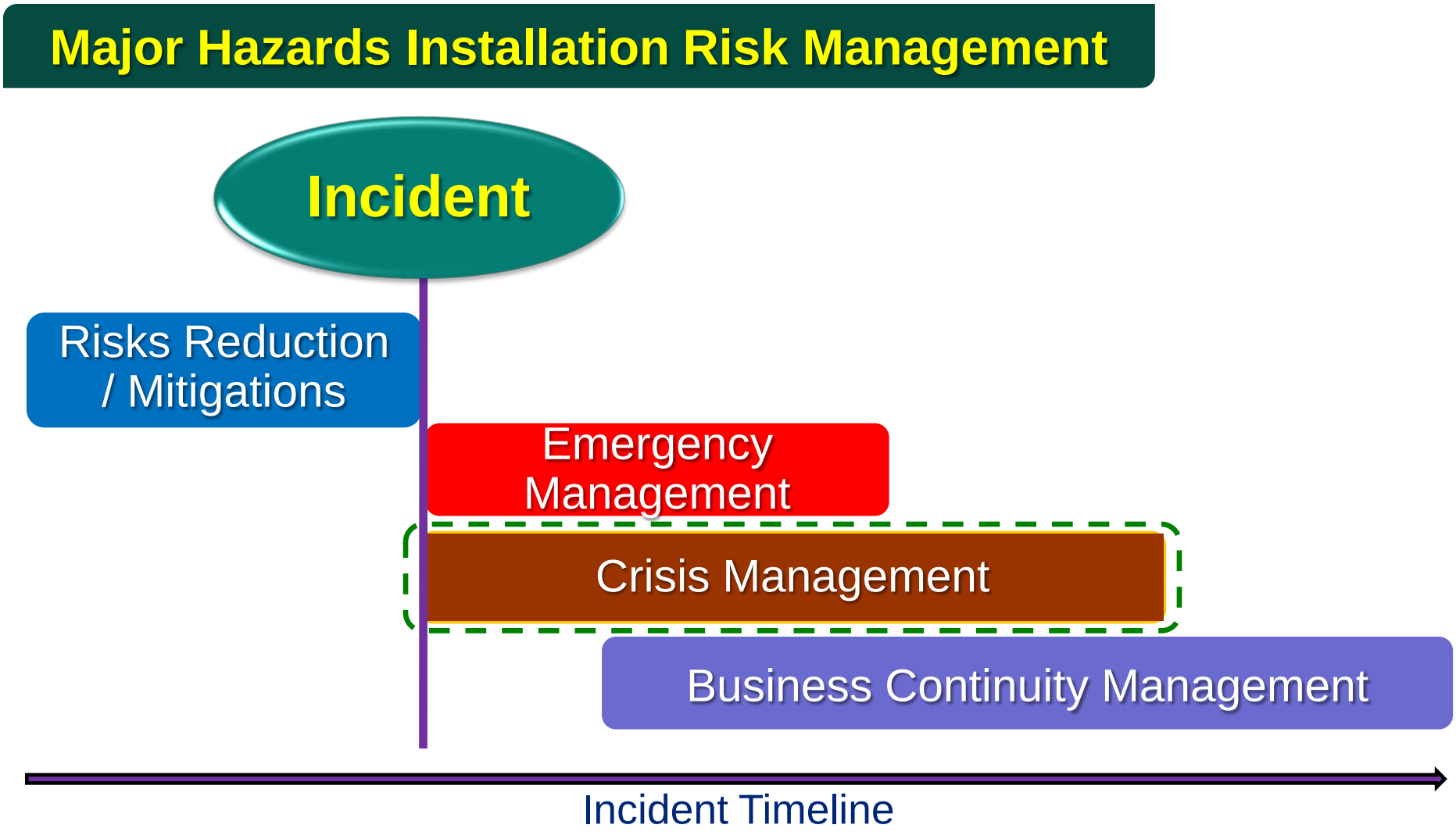
4. Crisis Management Plans



4. Crisis Management Plans

What is a Crisis?

4. Crisis Management Plans

Crisis Management - P A I R

1. • **P**re-incident Readiness
2. • **A**ctive Contingency Plan
3. • **I**ncident Response
4. • **R**ecovery & Return to Normalcy

4. Crisis Management Plans

Crisis Management

Construction of temporary by-pass road

Source: websites

4. Crisis Management Plans

What Constitute Crisis Management Plans?

Crisis Management Plan

- **Overview:** Responsibilities of Members of Crisis Management Team (CMT)
- **Summary:** Essential processes from Activation to Termination
- **Details:** (1) CMT Organization Structure and Roles, (2) Roles of Supporting Managers and Staff
- **Specific Guidelines:** Various Crisis / Emergency Categories
- **Communications:** Crisis Communication Guidelines and Key Contacts

4. Crisis Management Plans

Key Roles of Crisis Management Team

Safety Protection

- Employees & Contractors
- Neighbouring Community
- Company' assets, performance and image

High Level Communication

- Key stakeholders, Shareholders
- Government, Regulatory Agencies
- Media

Ensure Necessary Support

- Emergency Response Teams
- Resources, Funds
- Specialists' advice and technical input

Govt., SCDF
ERT Leader
Incident Command
Community & Neighbors
CAER
Management
Crisis Management HQ
Regulatory Agencies
Regulatory Affairs
Employees & Families
HR
News Media
Media Relations
Suppliers
Purchasing
Customers
Marketing & Sales

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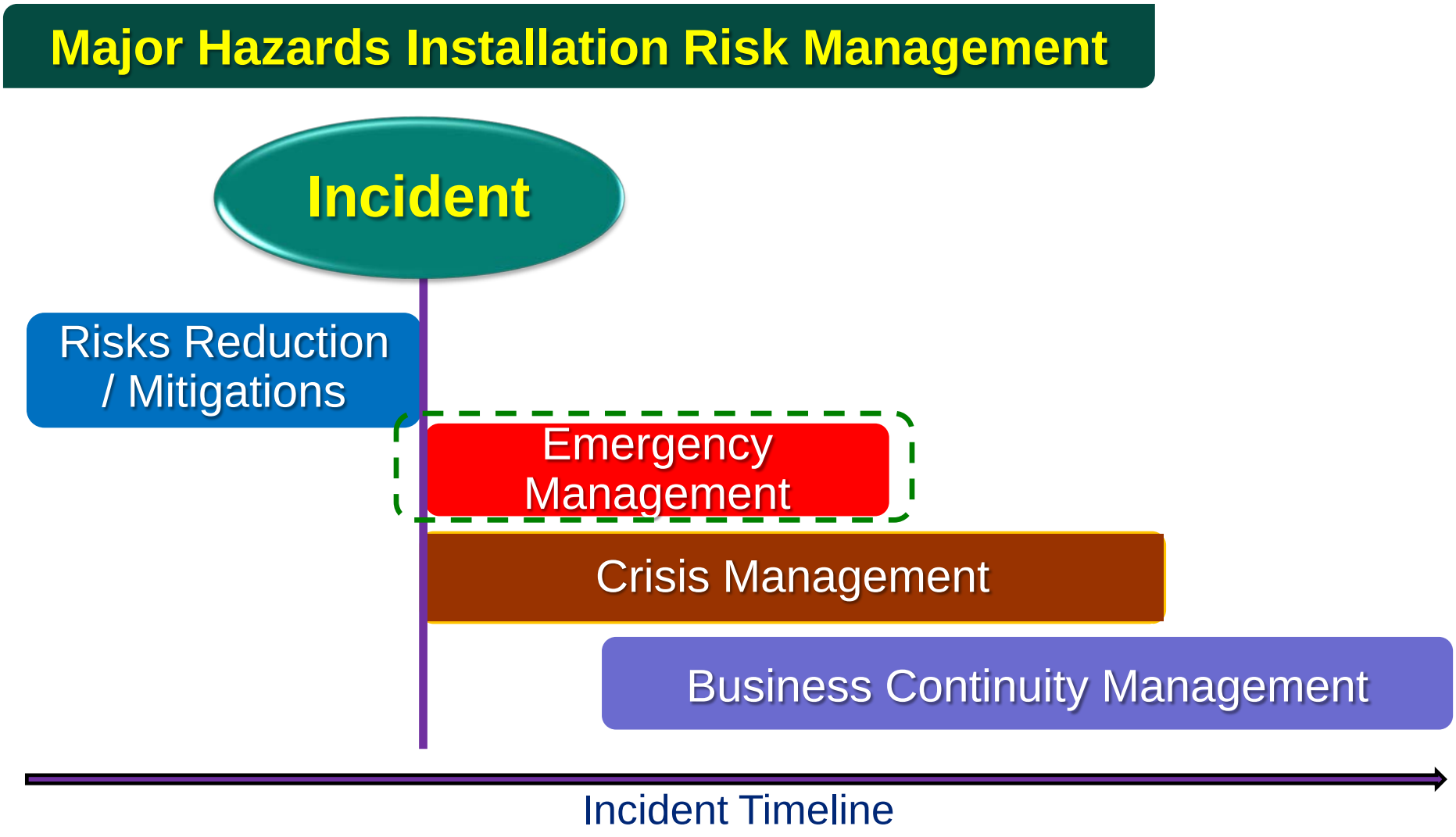
5. Emergency Response Plans



5. Emergency Response Plans

Singapore Petrochemical Complex Rules and Regulations
- Prevent Fire, Explosion, gas leak and Oil & HNS Spill

Petrochemical Corporation of Singapore (PCS) - Company ERP

- **Situation:** Area of Operations, Layout, Storage Area; Quantities of Hazardous Substances
- **Execution:** Concept of Operations, Containment of Emergency (shutdown, fire fighting); Coordination / Instruction
- **Service Support:** Provision of Fire Protection (detection) facilities, extinguishing / drencher systems; first aid
- **Command and Signal:** Incident Organisation, Appointment Holders (SMC, SIC, CERT); Communication

Source: PCS

5. Emergency Response Plans

Complex Emergency Organization

Incident HQ

Incident Site

SCDF

Complex Site Main Controller (SMC) - PCS GM of Plant

PCS Mgt Team

Complex SMC

Unaffected Co Mgt Rep

PCS Technical Team

(Engrg, HSE, Maint, Opns)

Asst SMC

PCS Gen Affair Team

(Medical, Log, HRA,Planning, Mkt, Legal)

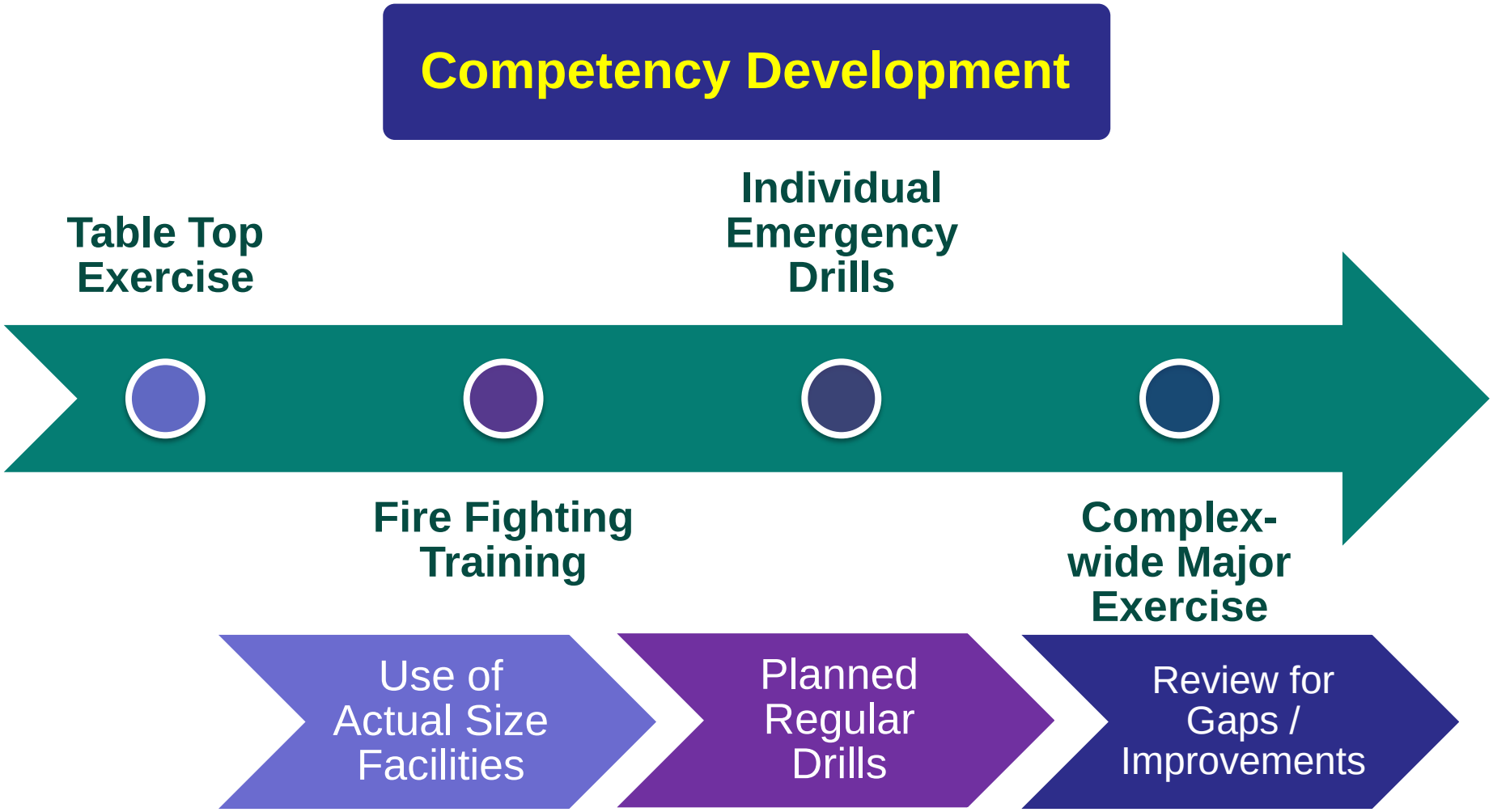
SIC

Company CERT

PCS Fire & Security

Source: PCS

5. Emergency Response Plans



Source: PCS

5. Emergency Response Plans

Fire Fighting Training - 1

PCS Fire Fighting Training Ground in PAM of Jurong Island

Source: PCS

5. Emergency Response Plans

Fire Fighting Training - 2

PCS Fire Fighting Training Ground in PAM of Jurong Island

Source: PCS

5. Emergency Response Plans

Individual Emergency Drills

PCS F&S and Individual Company Emergency Drill

Source: PCS

5. Emergency Response Plans

Complex-wide Major Exercise

Combined Exercise with Government Agencies including SCDF

Source: PCS

5. Emergency Response Plans

Fire Fighting Equipment and CERT PPE

PPE

- Fire fighting helmets + face shields
- Fire retardant gloves
- Fire fighting safety boots

PPE (cont'd)

- Fire fighting suits
- Hazmat suits
- Self-contained breathing apparatus

Mitigation

- Fire hoses
- Water / foam nozzles
- Water foam monitors
- Hazmat adsorbent
- Spill kits

First Aid

- Type A first aid kit
- Double-fold pole stretcher
- Fire blanket
- AED

Communication: Loud hailer, Walkie-talkie

Source: PCS

Process Safety in Respect to Business Continuity

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6. **Conclusion and Takeaway**

6. Conclusion and Takeaway

- Biz Continuity Mgt strategic to Organization
- Process Safety – key to MHIs Biz Continuity
- Leading Indicators contribute too Loss Prevention
- MHIs must commit to Risk Reduction to ALARP
- Crisis Management Plans and Emergency Response Plans must be in Place

"Always be Prepared, Identify Risks, Eliminate Threats and to Alleviate Potential Emergency Situations through Timely Mitigations."

Major Hazards Symposium 2017
28 July 2017

THANK YOU

Er. Lucas NG HK
General Manager of Plant

Process Safety Leadership

CS Teng

28th July 2017

SLP
Society of Loss Prevention
in the Process Industries

Agenda

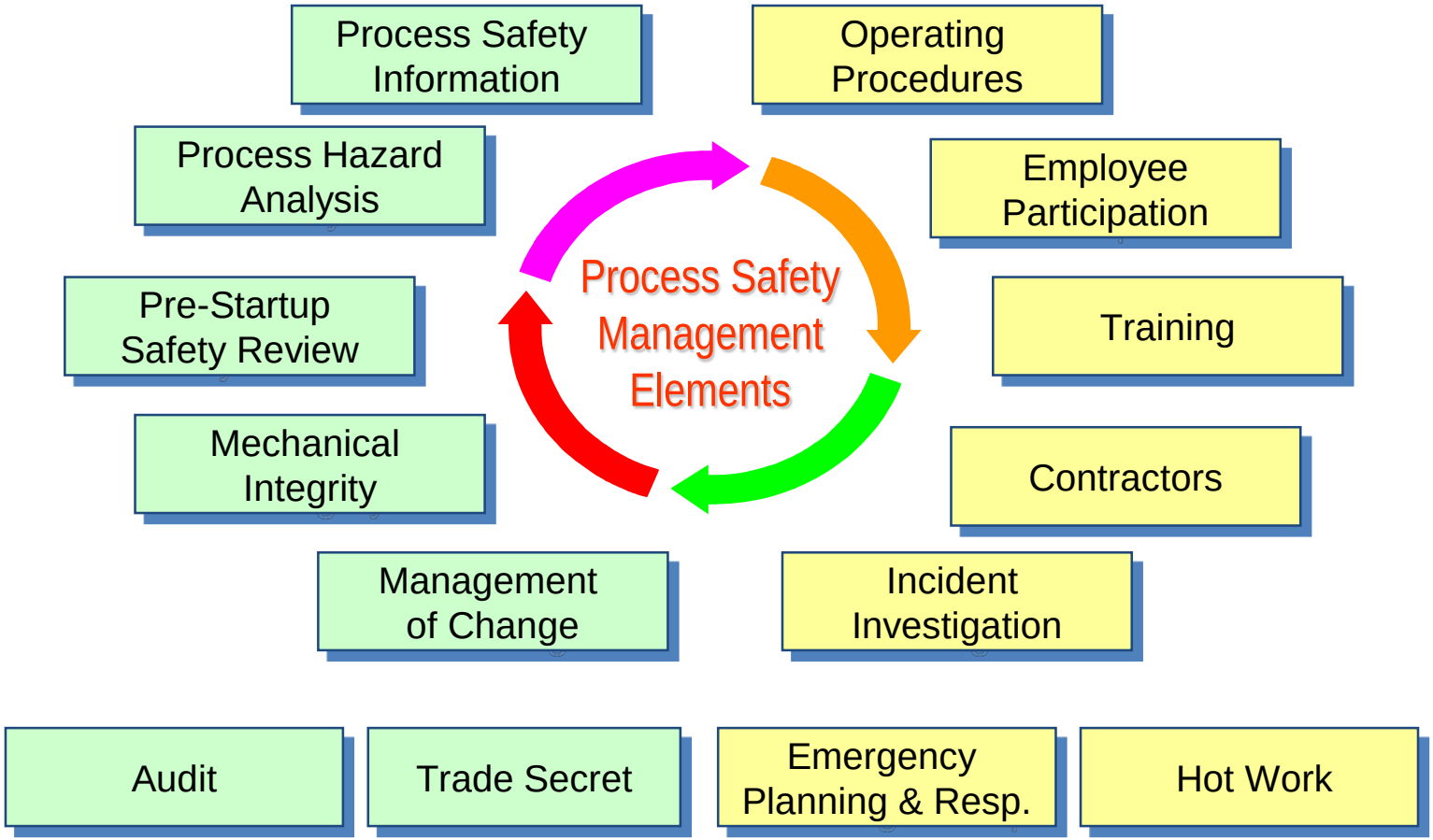
- OSHA PSM and WSH MHI Regulations
- Value Proposition
- Leadership
  - Management of Change
  - Process Understanding
  - Holding Self & Others Accountable
  - Collaborations & Networking
- Q & A

SLP Society of Loss Prevention in the Process Industries

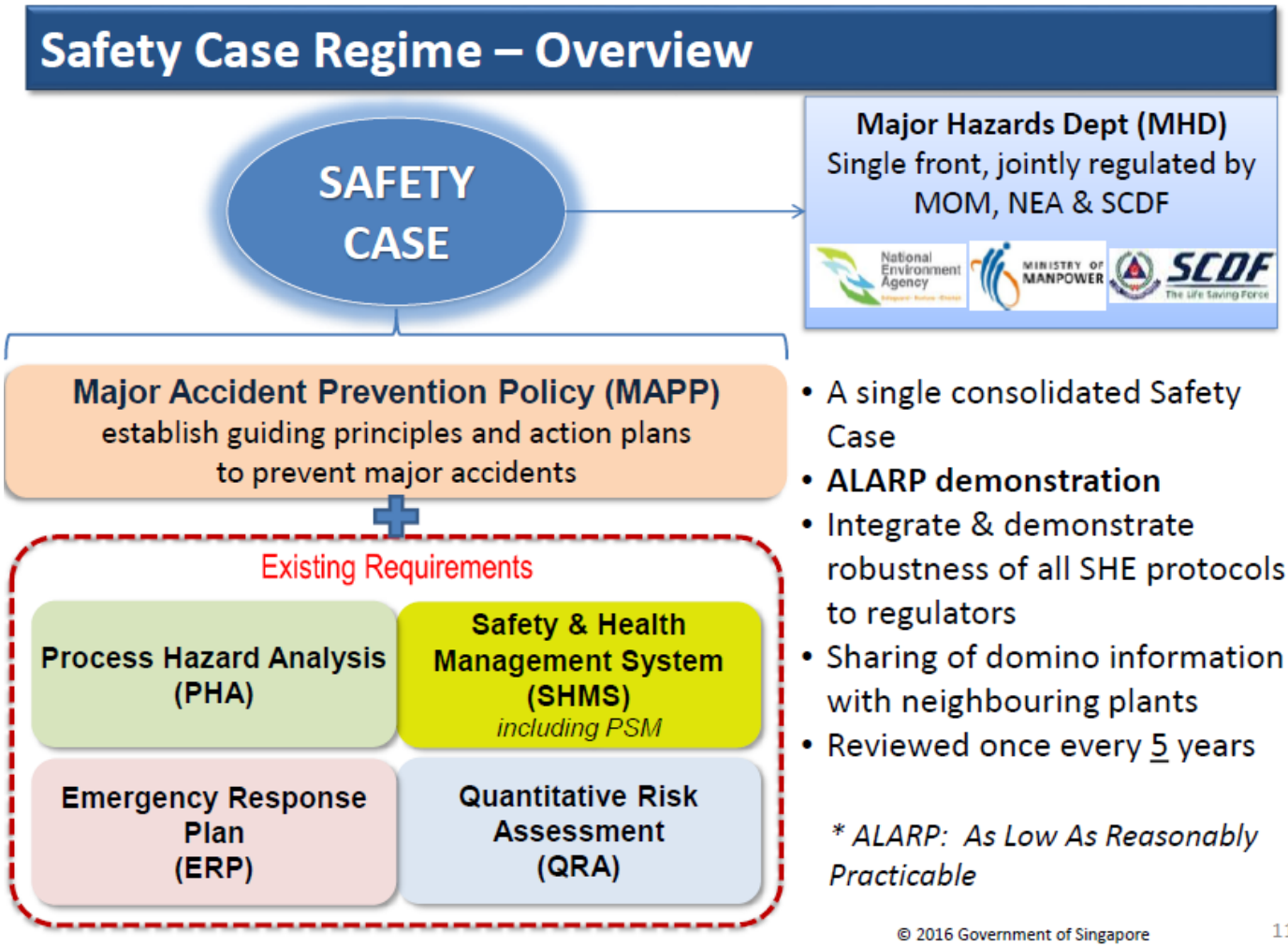
OSHA Process Safety Management (PSM) & WSH Major Hazard Installations (MHIs)

SLP
Society of Loss Prevention
in the Process Industries

PSM (OSHA 29 CFR1910.119)



2017 WSH – MHI Regulations



Pyramid of Safety Case

SLP

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Value Proposition

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Value Proposition

- It’s all about people
  - No multiple injuries
  - No pains and suffering
- Winning the hearts and souls of people to really believe and strive for injury free workplace
  - Safety is a right thing to do
  - Safety is good for business

Process Safety Leadership

Society of Loss Prevention
in the Process Industries

Leadership

Implement effective management of change to reduce risks

Review changes, establish robust risk assessments and implement control measures

Invest in educational programs, improve process understanding

Commit to knowledge management

Partner with Stakeholders to agree and accept accountability and Ownership

Address issues and strengthen ownership to issue resolutions

Encourage collaborations between industry and regulatory agencies, partner to learn from best practices

Continual improvement through Collaborations & Networking

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Management of Change

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Managing Changes

Focusing on Design for Safety

Enabling Effective Risk Assessments & Control Measures

Performing Process Confirmation

- **Zero Work Injury**
- **Higher Productivity, Better Efficiency, Enhanced Corporate Image & Improved Competitive Advantage**

Embracing Safety in Management of Change

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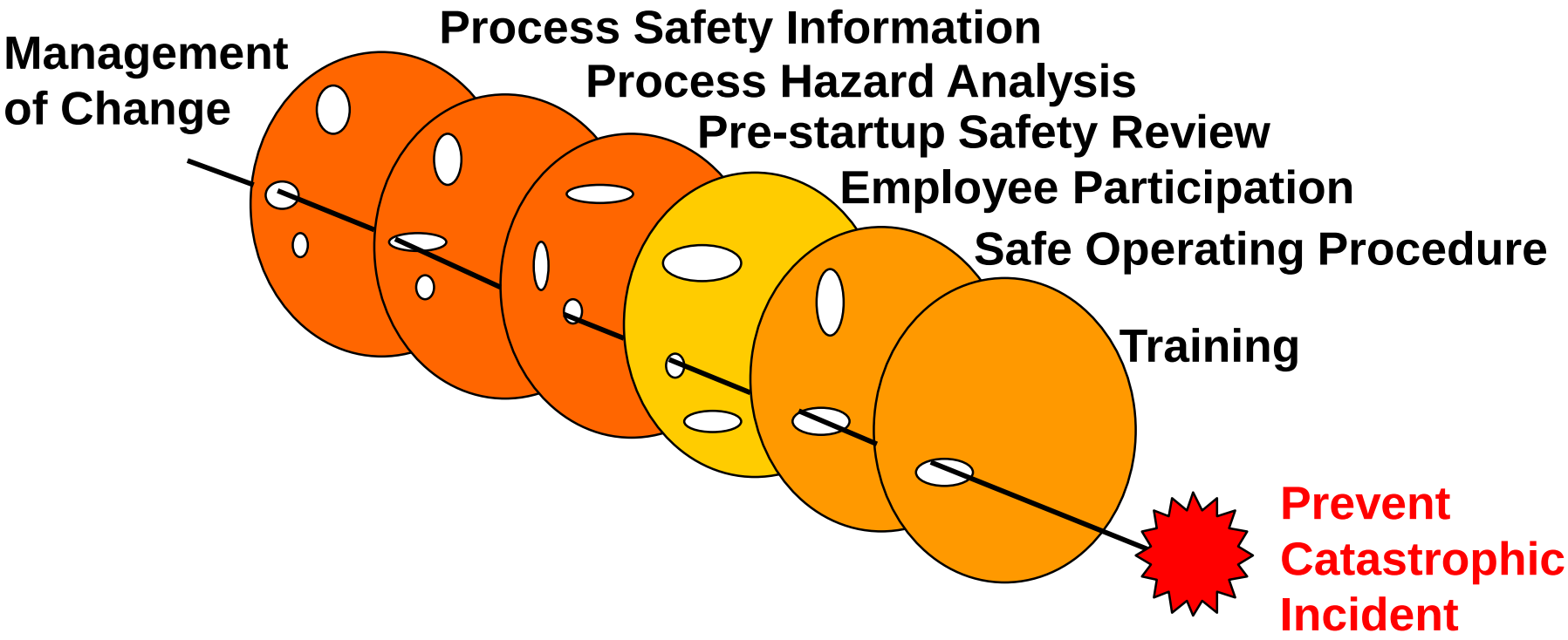
Integration of Elements



Process Understanding

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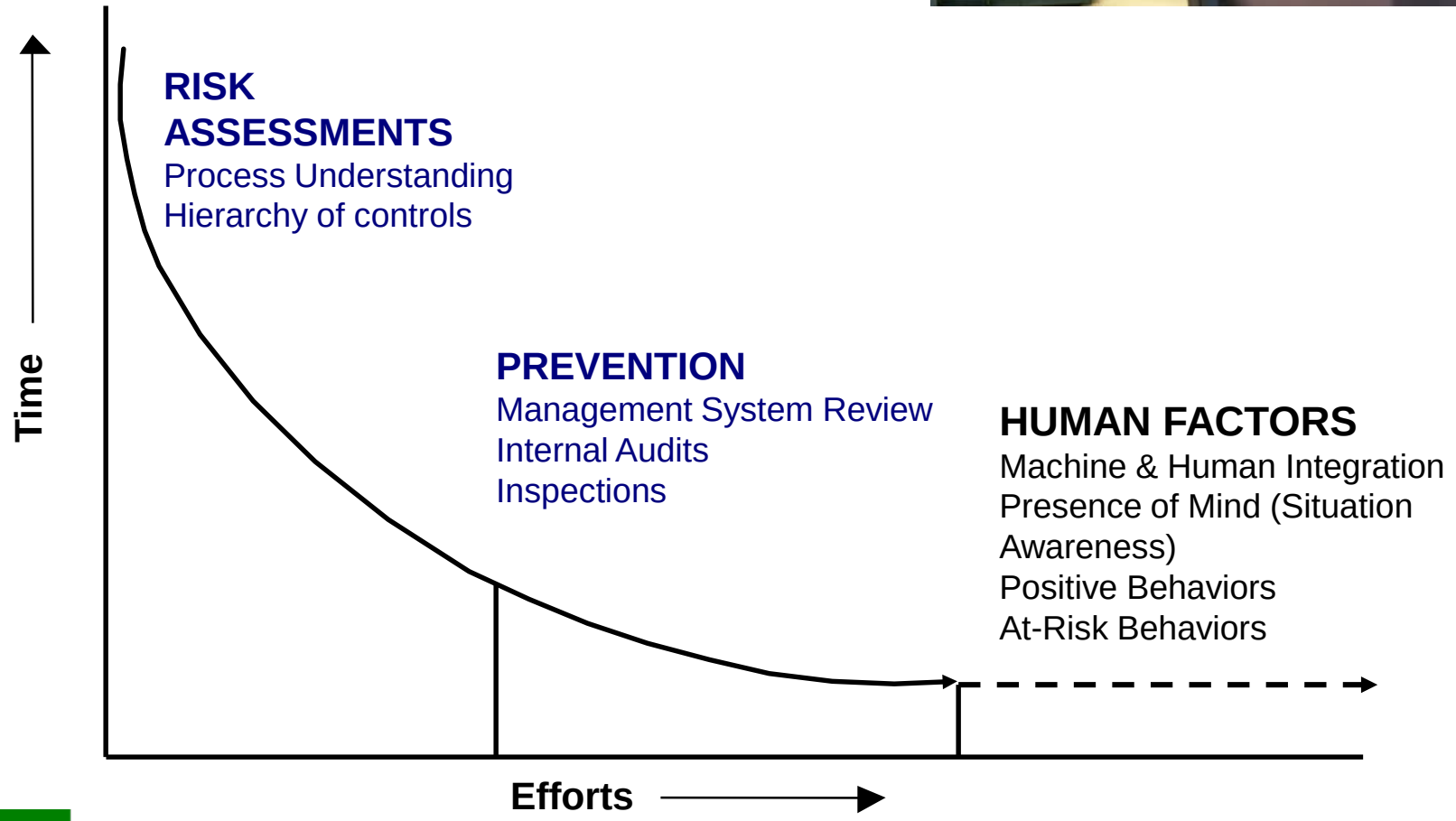
Knowledge Management

Inspiring People to Work Safely
Applying Right Knowledge & Skills for Safe Work



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Process Confirmation

RA intents to address risks to prevent getting hurt

SWP is designed to do tasks in a safe manner

Do Things Right can't meet org. expectation anymore

Risk Assessments

Safe Work Procedure

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Holding Self & Others Accountable

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Shared Accountability

It’s not limited to:

- Occupiers / Employers
  - Commitment & Leadership
  - Duty of care
- Managers / Supervisors / SMEs
  - Risk assessments & control measures (design for safety)
  - Accountability & Ownership
- Employees / Workers
  - Discipline & Integrity
  - Compliance to safe work procedures

Legal Liability

THE STRAITS TIMES SATURDAY APRIL 29, 2006

Shun Sugawara, 56, project director

He admitted that he failed to take all reasonably practical steps to ensure workplace safety when the retaining wall system was being built. He was fined $120,000.

Kazuo Shimada, 51, design manager

He admitted making errors in the design of the temporary works, which led to the retaining wall system being weakened and eventually collapsing. He was fined $160,000.

Paul Broome, 50, project coordinator

Broome admitted to the same charge as Shimada. He was also fined $160,000.

» NICOLL HIGHWAY COLLAPSE TRIAL

3 senior Nishimatsu execs fined

By Elena Chong

THE final chapter in the criminal proceedings of the Nicoll Highway saga came to a close yesterday when three senior executives of the Nishimatsu Construction Company were given substantial fines for their part in the collapse, which left four workers dead.

Project director Shun Sugawara, 56, was handed a $120,000 fine, while design manager Kazuo Shimada, 51, and project coordinator Paul Broome, 50, were each fined $160,000.

Despite the stiff fines, the sentence came as a relief to all three, who were facing a maximum penalty of one year in jail or a $200,000 fine, or both.

Nishimatsu, the main contractor on the Circle Line MRT worksite, was handed the maximum $200,000 fine in January.

The retaining wall at the worksite collapsed on April 20, 2004, causing a 100m section of the Nicoll Highway to cave in.

Four workers lost their lives: crane operator Vadivel Nadesan, 44, construction worker Liu Rong Quan, 37, supervisor of works Tan Lock Yong, 54, and construction supervisor Heng Taow Phave, 40.

Sugawara, who was away at a meeting in Japan that day, admitted failing to take all reasonably practical steps to ensure that the workplace was made and kept safe when the retaining wall system was being built.

Shimada and Broome were charged with failing to ensure that the workplace was of sound construction and properly maintained.

They admitted making errors in the design of the temporary works, which resulted in the retaining wall system being weakened and eventually collapsing.

Investigations showed that the monitoring system at the site was inadequate and that there were two design errors in retaining walls.

In her 27-page grounds of decision, District Judge Valerie Thean said that if the instruments at the site had been properly monitored, the defendants would have realised that the walls were moving and taken appropriate action.

The careers of all three men are likely to suffer serious consequences as a result of their convictions.

Broome's lawyer said he had suffered severe post-traumatic stress disorder since the incident.

The lawyer added that Broome was not a geotechnical expert and had relied entirely on Shimada and professional designer Maunsell Consultants to endorse the design of the walls.

Sugawara, said the judge, had been too reliant on his subordinates while Shimada had, among other things, failed to initiate a design review of the temporary works.

"In coming to the appropriate sentence, it is important to note that...there was no allegation even that these men were reckless or generally incompetent," the judge said.

She also explained her decision not to jail the three men.

She said: "Their negligence, although sustained over a period of time, were...errors of professional judgment made against a backdrop of a wider systemic failure.

"Custodial sentences are not appropriate on these facts."

Now that the criminal cases are over, families of the affected victims may pursue their claims for damages.

The only other individual convicted in the case was ex-Land Transport Authority project director Ng Seng Yong, 48, who was fined $8,000 for not exercising "due diligence and "reasonable care" in monitoring excavation works and assessing instrumentation readings.

Works is continuing at the Circle Line MRT Line, with the whole project now expected to be completed in 2010.

1	WSHA holds managers and directors of companies personally accountable for safety and health practices at their workplace (S. 48)
2	"A director shall at all times act honestly and use reasonable diligence in the discharge of the duties of his office." Companies Act Section 157(1)

Source: Singapore MOM presentation

Collaborations & Networking

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Collaborations & Partnership

Industry

Regulatory Agencies

Institutions

Knowledge Management
Competency (Knowledge, Skills & Experience)

Consulting for ALARP

Pushing for Innovation

Enabling Effective Work Processes

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1 More to go

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Quote (Trevor Kletz)

“There’s an old saying that if you think safety is expensive, try an accident.

Accidents cost a lot of money.

And, not only in damage to [the] plant and in claims for injury, but also in the loss of the company’s reputation.”

Q & A

Thank You

Society of Loss Prevention
in the Process Industries

Singapore Refining Company Private Limited

Company Registration No. 197900084K

Safety Case – ALARP Concept & Demonstration

Amit Bhatnagar

Process Safety Manager

Singapore Refining Company Pte. Ltd.

My Background

- **Education:**
  - Bachelor in Chem. Engg. (PU India 1986)
  - Masters in SHE (NUS 2008)
- **Work Experience:**

  ~ 30+ years experience in Chemical/ Petrochemical/ Refining industry
  - Operations, Plant technical support (Ammonia, PVC, PP, LLDPE)
  - Process Design (FPSO)
  - Dedicated Process Safety role for last 8 years in SRC

Agenda

- What is Safety Case (SC) regime
- ALARP & Its Demonstration
- Sample ALARP Demonstration work process
- Presentation re-cap

What is the Safety Case Regime

- A Case which an **Major Hazard Installation (MHI)** makes to the regulator, setting out how risks from **Safety Critical Events (SCE's)** have been reduced to **As Low As Reasonably Practicable (ALARP)** ensuring safe operations in a sustainable manner
- Successful "**Safety Case**" application : **license to operate MHI**

Main Components of a Safety Case

1. **Descriptive Info of MHI**
   History, plot plan, PFD, P&IDs, Equipment details, Hazardous chemicals holdup (process & storage) & location and other details
2. **Major Accident Prevention Policy (MAPP)**
3. **Safety Management System (SMS) description**
4. **Risk assessment**: Predictive aspects & identification of Safety Critical Events
5. **Technical aspects of a Safety Case,** including controls (prevention and mitigation measures) to prevent MASs from occurring
   - **Process safety**
   - **Mechanical**
   - **Electrical, controls and instrumentation**
   - **Human factors**
6. **Emergency Response Plan (ERP)**
7. **ALARP demonstration for Safety Critical Events**

*SC contains information required to **demonstrate** that MHI can be **operated safely**.*

Significant Effort Required to Develop & Operationalise Safety Case

Safety Case Objectives In SRC

Shall we implement Safety Case to meet Regulatory Requirement only?

Safety Case Objectives In SRC

Safety Case Regime shall help SRC to progress from

"We Think" to "We Know"

for the prevention and mitigation of major accidents

SC development work process devised in SRC to maximize use of in-house resources to develop and operationalise Safety Case

What Is ALARP & Its Demonstration

Requirement Of Safety Case

- Main requirement of Safety Case regime is through their safety case, MHI's shall **demonstrate** that they have identified and assessed **all major accident risks** and have **taken all steps necessary** to reduce these risks to a level **As Low As is Reasonably Practicable (ALARP)**
- To make a "**demonstration**" means to **justify** through the **information** given and the **reasoning** provided
- Making a demonstration does **not** mean **"proving beyond reasonable doubt"**
- Decisions on **additional control measures (barriers)** to bring risk levels down to ALARP should be made by a **team** comprising of **qualified and experienced technical personnel**

Key Components Of Safety Case (SC)

Consolidating key requirements of SC, ALARP Demonstration requires:

- Identify **All Safety Critical Events** which can lead to major accidents.

Requirements on Risk Assessment covered in SC TG Chapter 4: Predictive Aspects

- Review **adequacy of existing/ proposed barriers**.

Requirements on Barrier analysis covered In SC TG Chapter 5: Technical Aspects

- Identify **practicable control measures (barriers)** which can be implemented to prevent a specific **Safety Critical Event** from happening
- Plan to **implement reasonably practicable barriers**. **Justify** the reasons for not implementing including those being **gross disproportionate**.

Requirements on ALARP Demonstration covered In SC TG Chapter 7

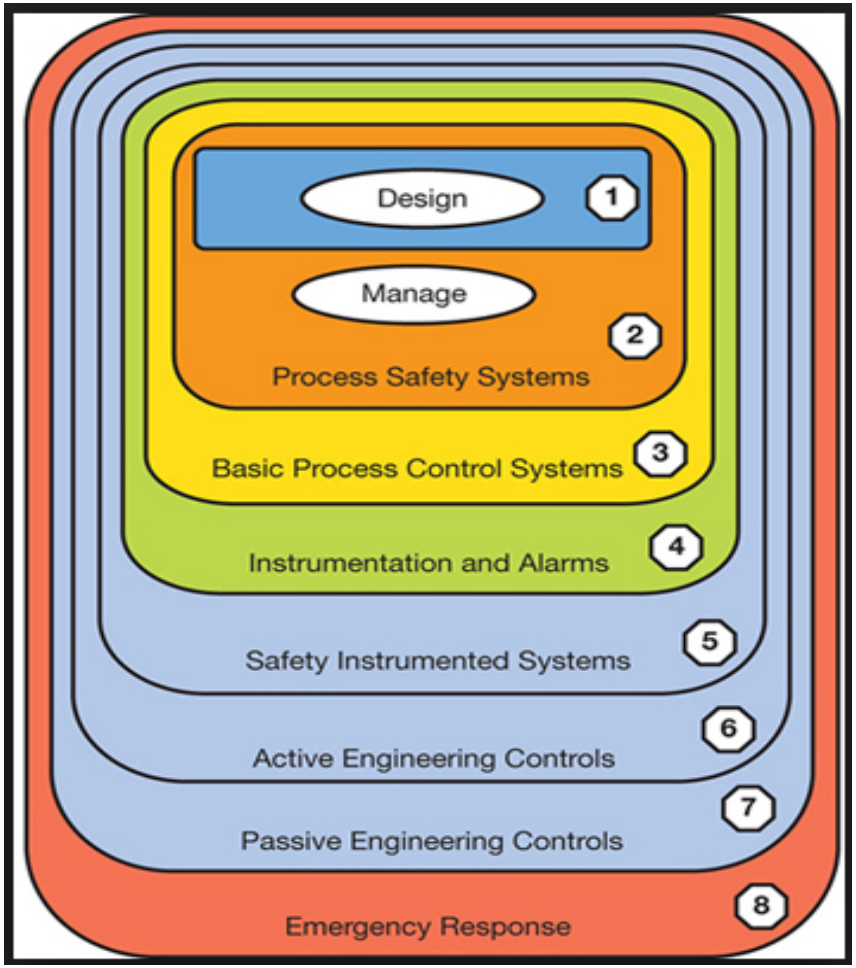
ALARP Demonstration is a process Not an "End Goal"

ALARP Key Concept: Practicable

Control Measure being proposed should be **technically possible** to implement.

Established technologies which can be considered practicable are:

- Inherent Safer systems
- Basic Process Control & Alarm systems
- Emergency shutdown system (temperature/ level/ pressure/ flow/ flame out/ vibration/ composition etc.)
- Pressure Relief System
- Emergency Response Systems (Gas/ Heat detectors, deluge system etc.)
- Critical operating procedures (last resort)
- Others (based on team discussion)……



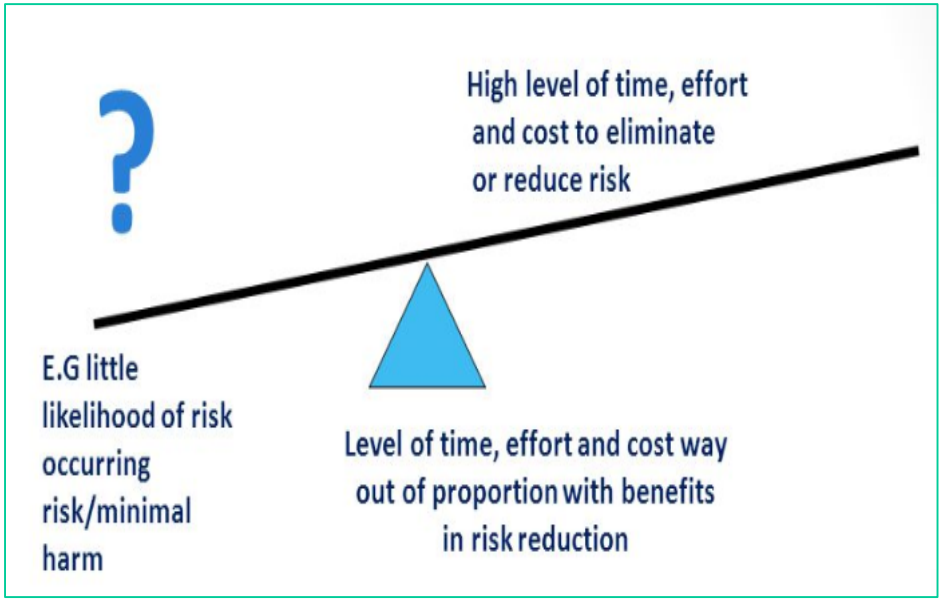
Key Concept: Reasonably Practicable

Reasonably Practicable: If a proposed control measure is **practicable** and the **benefits gained** by their implementation is higher than the **sacrifice** (in terms of **money, time and efforts**); then the proposed control measure is considered **Reasonable Practicable** and should be implemented.

The criterion is reasonably practicable not reasonably affordable

Key Concept: Grossly Disproportionate

A point where **any incremental sacrifice (time, money, effort)** to implement more control measures does not derive **additional benefits** over the sacrifice



e.g. few MM S$ to prevent 1 ~ 2 minor injuries is grossly disproportionate while few MM S$ to prevent a major accident which can impact many including potential fatalities will be reasonably practicable

Key Concept:

- **Good Practices**

  Regulatory, internationally recognised standards and codes, risk management practices and company internal best practices that are developed by competent organisations to manage well-understood hazards arising from their activities e.g. Singapore standards & CPs, API, ASME, IEC, NFPA, company best practices

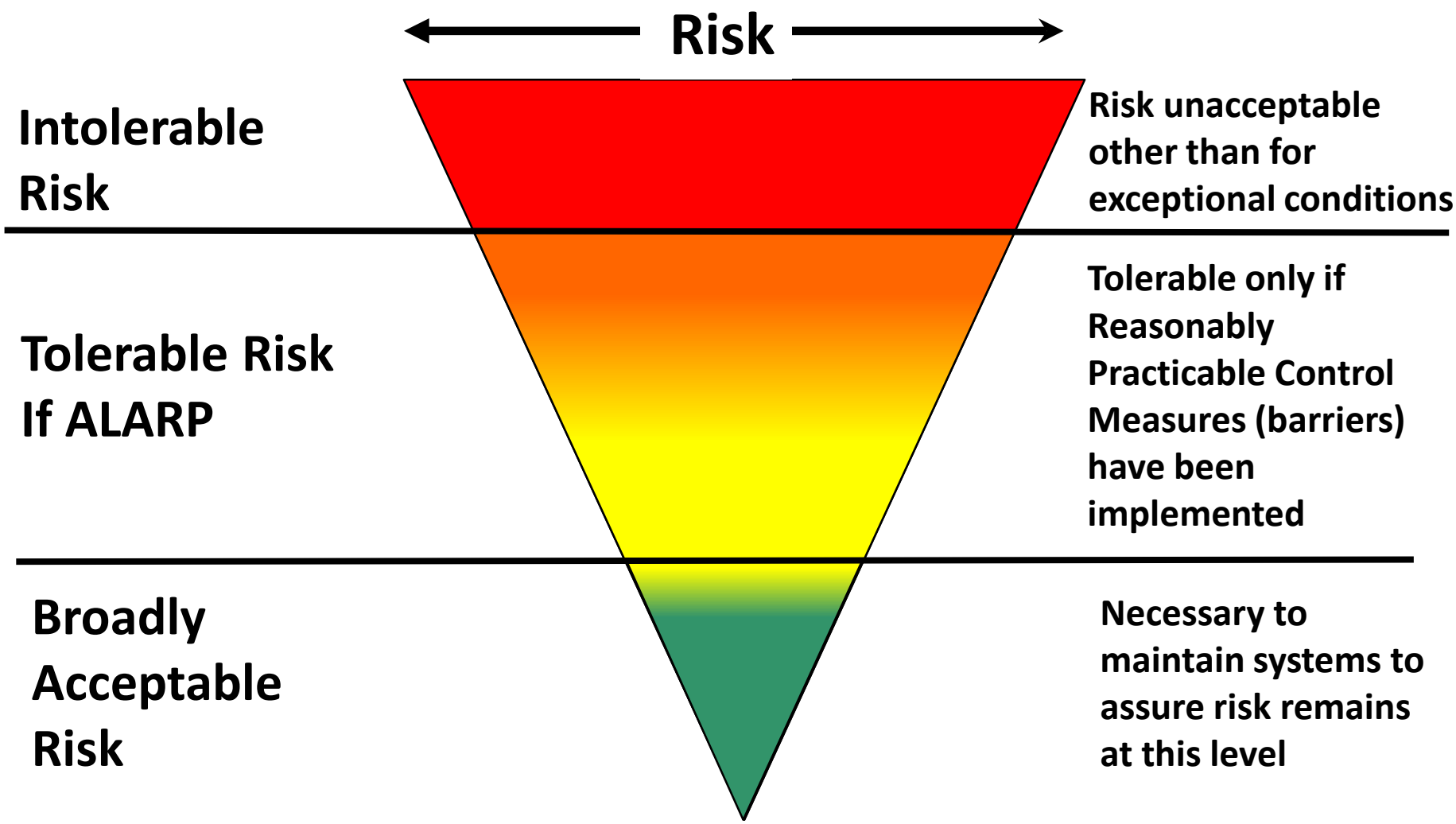
NFPA®

ASME
SETTING THE STANDARD

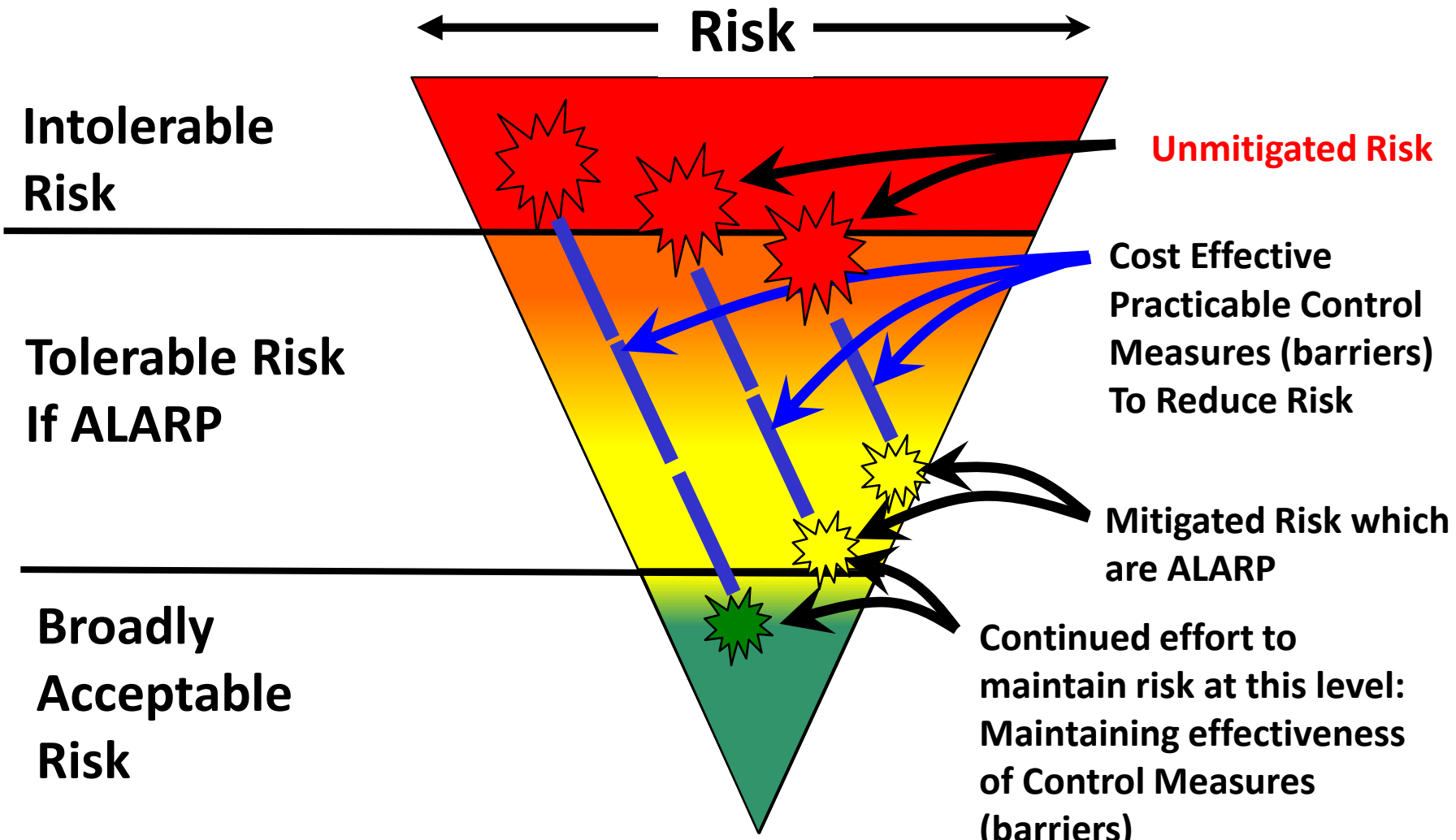
American Petroleum Institute

IEC
INTERNATIONAL ELECTROTECHNICAL COMMISSION

ALARP Risk Triangle:



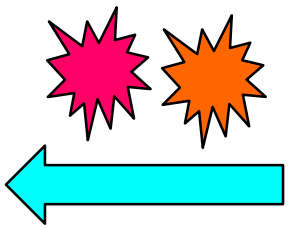
Applying ALARP Risk Triangle for Demonstration



ALARP Demonstration By Risk Matrix

Major Accident Scenario Range

Severity \ Likelihood	Rare (1)	Remote (2)	Occasional (3)	Frequent (4)	Almost Certain (5)
Catastrophic (5)	5	10	15	20	25
Major (4)	4	8	12	16	20
Moderate (3)	3	6	9	12	15
Minor (2)	2	4	6	8	10
Negligible (1)	1	2	3	4	5



Unmitigated risk

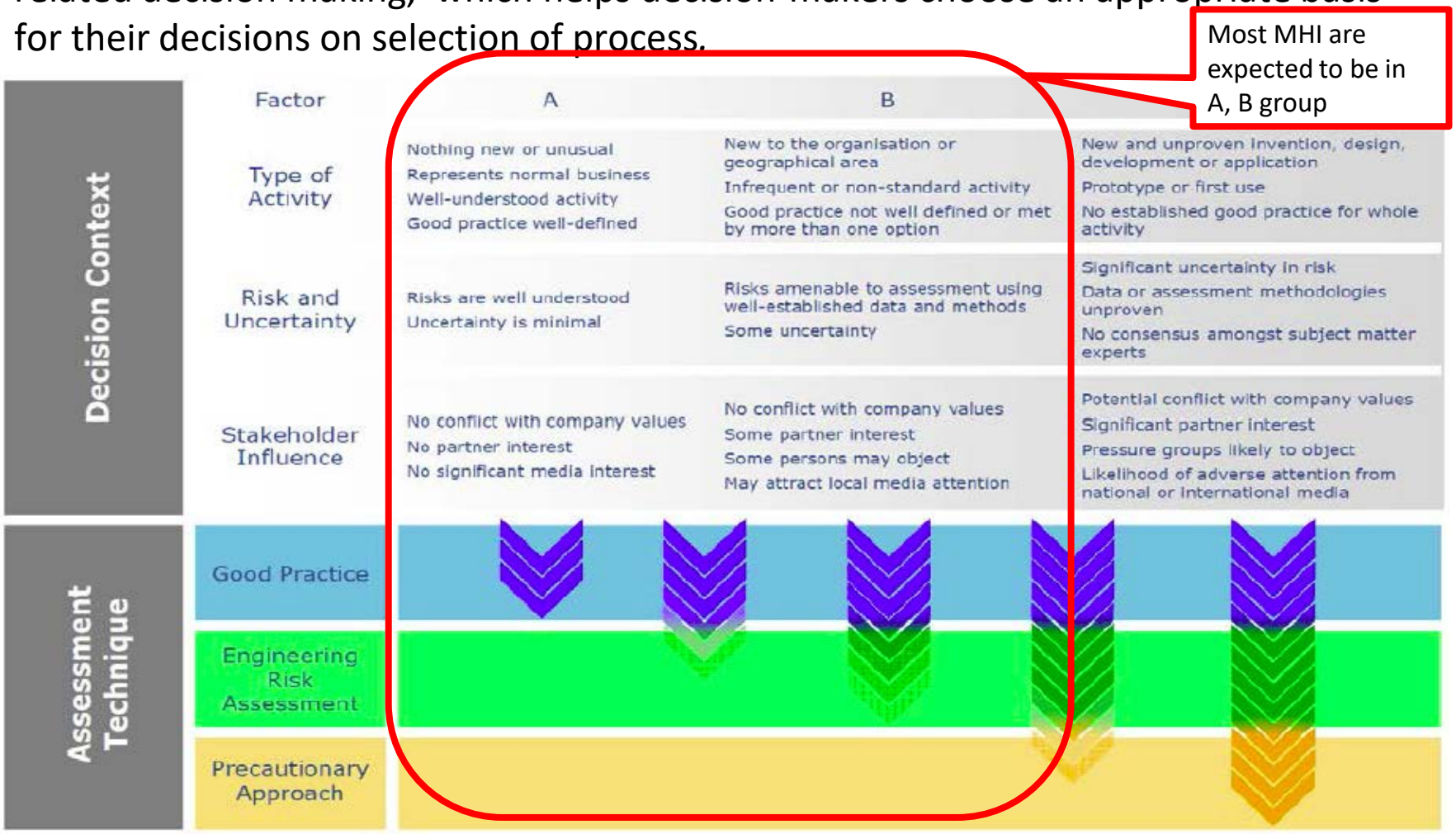
Practicable Control Measures (barriers)

Risk at ALARP

Risk Matrix from WHSC CP on Workplace Safety and Health (WSH) Risk Management 2012

ALARP Demonstration Decision Making Framework: At Organisation Level

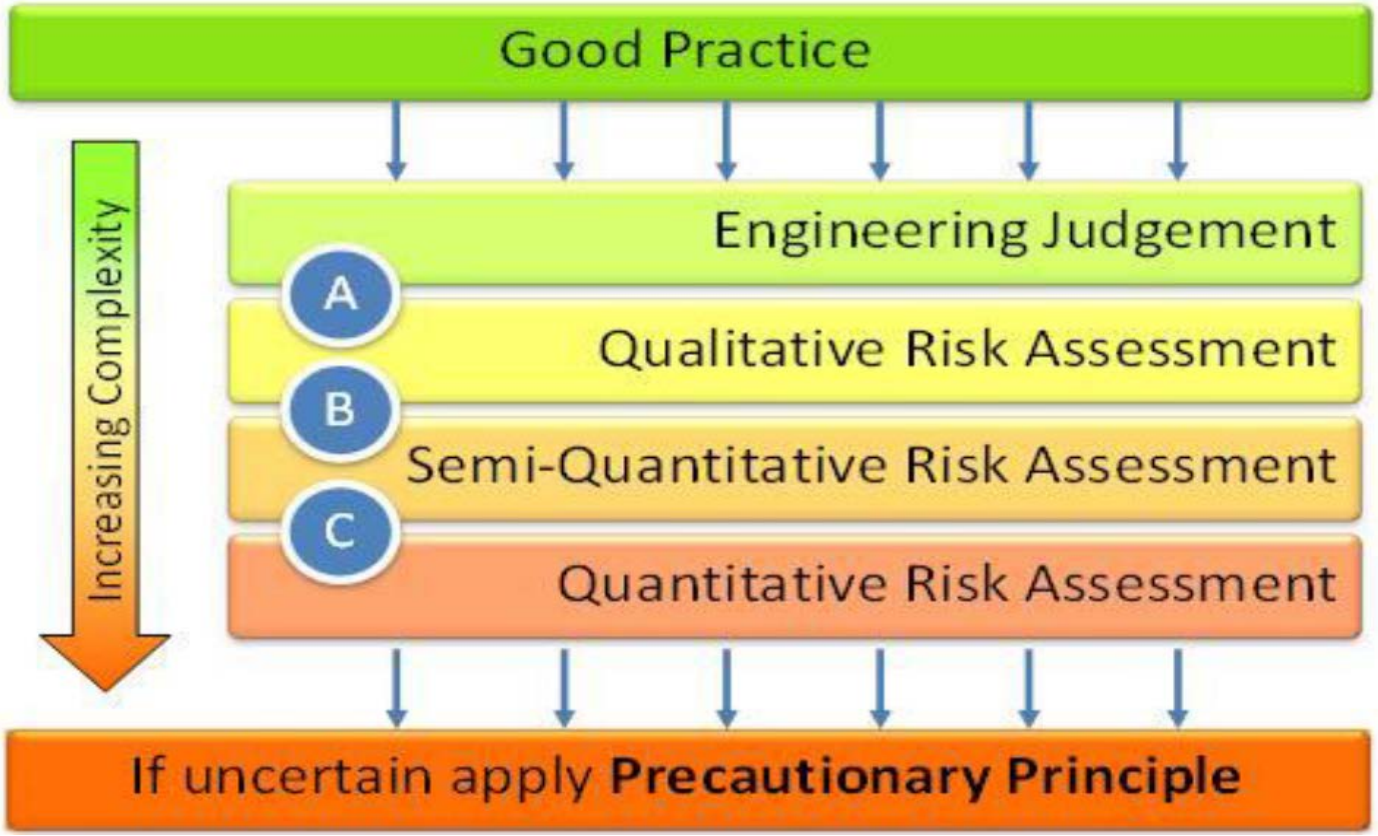
Oil & Gas UK", formerly UKOOA, 2014 developed below framework to assist risk-related decision making, which helps decision-makers choose an appropriate basis for their decisions on selection of process.



ALARP Demonstration

- No prescribed methodology for ALARP demonstration
- Appropriate methodology selection based on **proportionality principle**
  - **Good Practice Compliance (must for all methods)**:
    - Comparison with codes and standards
    - Audit against good practice
  - **Qualitative methods:**
    - Engineering Judgement
    - Risk Assessment Method
    - Performance data
    - Improvement approach
  - **Quantitative method:**
    - Cost Benefit Analysis (CBA)
- **Proportionality Principle:**
  - Level of detail in ALARP assessment **proportionate to risk**
  - Use **simple techniques** for less complex/ lower risk scenarios while **more complex and detailed assessment** for High risk/ high complexity scenarios
  - No assessment may be required for a **low risk scenarios** in **Broadly Acceptable risk category**

ALARP Demonstration Decision Making Framework: Individual SCE Review



A: Low risk implication on control measure (barrier) implementation
B: Some complexity in decision on balance between cost and benefit achieved
C: Highly complex solution requires detailed assessment on balance between cost and benefit achieved

ALARP Decision Making Framework: Individual SCE Review

- **Good Practice:**
  - Refer slide 14
- **Engineering Judgement**:
  - **High-level analysis and assessment** conducted by **experts** who have good insight and understanding of the mechanisms that might lead to realisation of hazard and its potential consequences.
  - Example: selection of mechanical seal for pumps handling dangerous substances…
- **Qualitative Risk Assessment**:
  - Uses only **team judgement for assigning consequence & Likelihood**
  - Due to qualitative nature of the technique and coarseness of assessment, can only be used to assess well-understood hazards with well-understood risk reduction measures
- **Semi-Quantitative Risk Assessment**:
  - Similar to qualitative risk analysis, but with **additional numerical bands of consequence and likelihood**, which are combined together to give a risk classification.
  - Provides a more sophisticated basis for assessing barriers than qualitative risk analysis, but is less accurate than quantitative risk assessment.

ALARP Decision Making Framework: Individual SCE Review

- **Quantitative Risk Analysis (Cost Benefit Analysis):**
  - Detailed QRA study is carried out to **calculate cumulative risk (numerical value)** to a person who is exposed to Safety Critical Event(s) at a particular location
  - Numerical value for the **risk reduction achieved by implementing a additional barrier** can be calculated
  - Calculate the **Proportion Factor (PF)**

$$\frac{Cost}{Benefit} > Proportion\ Factor\ (PF)$$

  - PF helps to determine if it is **reasonably practicable to implement the proposed additional barrier.**
    Greater the risk, greater PF required to achieve ALARP
    PF ~ 1 when close to "broadly acceptable
    PF ~ 10 when close to "intolerable"
    - Include all appropriate costs in implementation including project cost, production loss etc.
    - Include all benefits achieved by preventing the scenario
  - **Extremely resource intensive** (along with specialist consultant services): typically done for selective highly complex SCE's

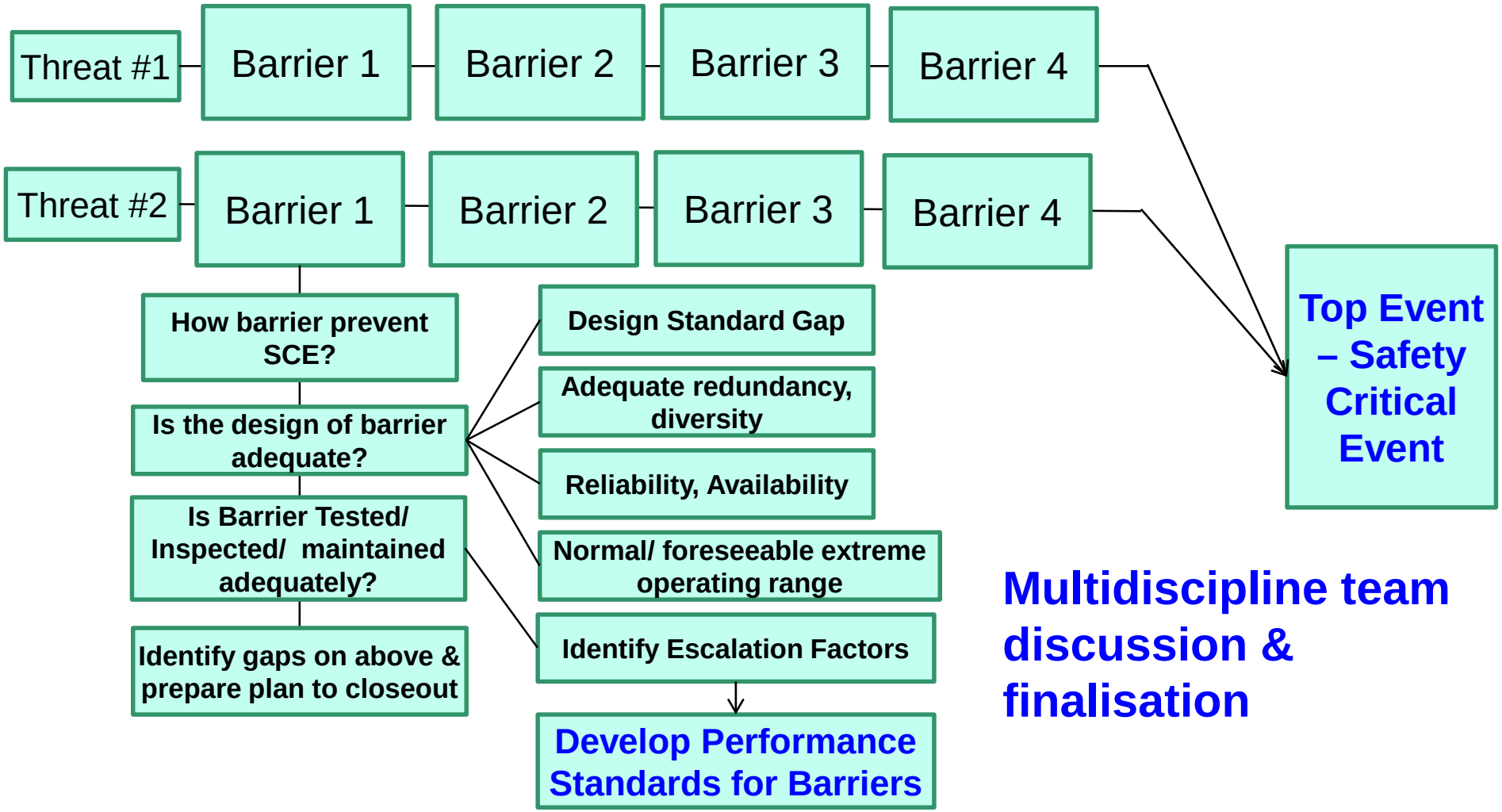
ALARP Decision Making Framework: Individual SCE Review

- **Precautionary approach**
  - Applying conservative assumptions resulting in proposed controls measures being more likely to be implemented
- **Reverse ALARP**
  - Using QRA or cost benefit analysis to justify a higher risk option for new projects or removal of an existing control measure in existing facilities

Selecting Additional Control Measures (Barriers)

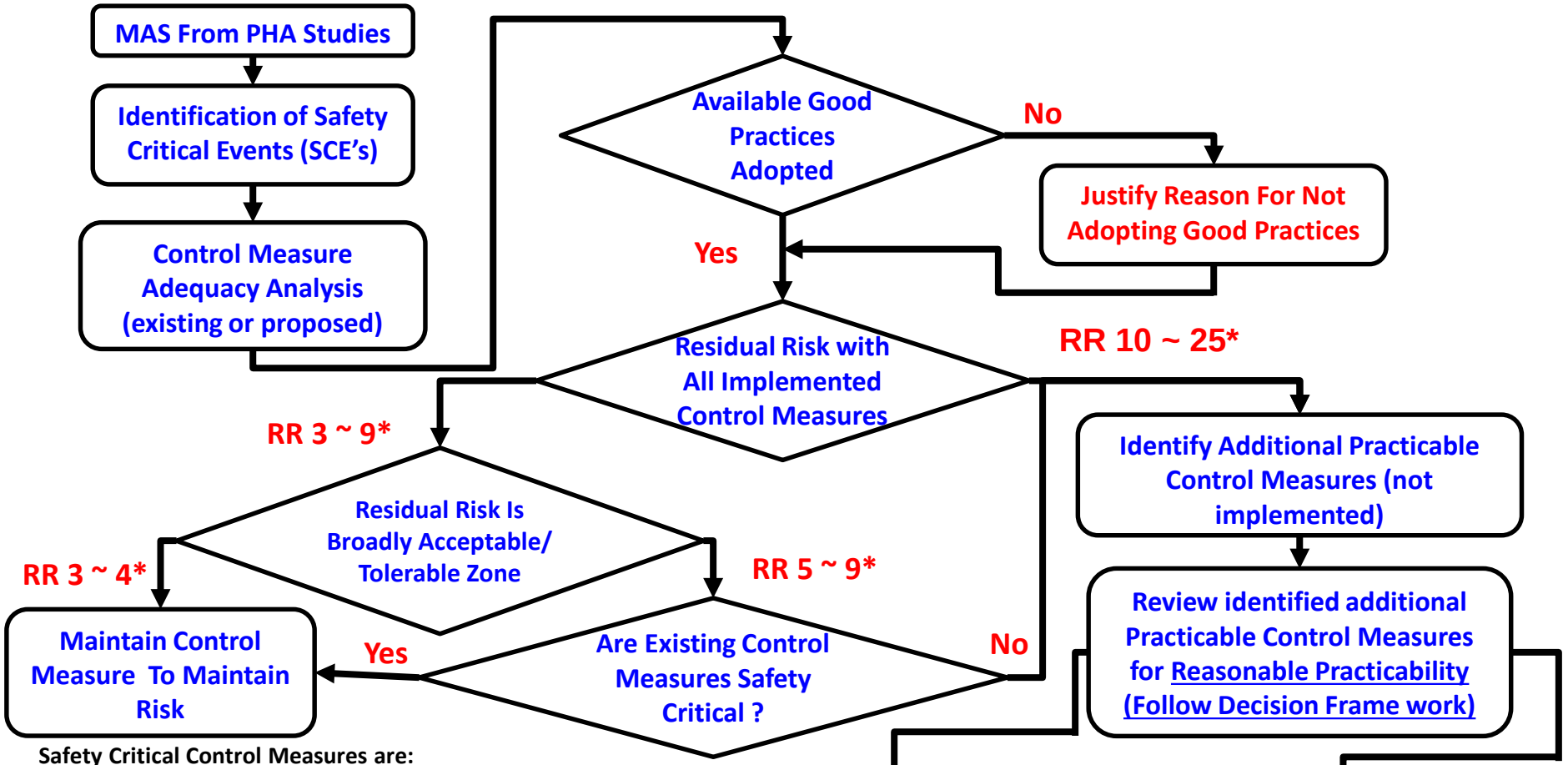
Methodology for Understanding Control Measures	Points to Consider
Control Measure Hierarchy • **Inherent safety** • **Prevention measures** • **Mitigation measures**	• Is there an option higher up the hierarchy that would more effectively eliminate or manage the hazard? • Where appropriate, is there a spread of controls across the hierarchy?
Types of Control Measures • **Technical** • **Other (SHMS, procedural)**	• Is there an appropriate spread of technical and other controls?
Common Mode Failures	• Have failure modes been identified for each control measure and then compared to identify common mode failures?
Layers of Protection • **Design standards** • **Control systems** • **Operating procedures** • **Safety devices** • **Emergency systems**	• Are the layers of protection provided adequate for the level of risk posed by the hazard?
Operating Circumstances • **Environment** • **Operating conditions** • **Activities being carried out**	• Have the controls been assessed for effectiveness over the range of different operating circumstances they may have to operate in?

Ensuring Barrier Adequacy



Multidiscipline team discussion & finalisation

Sample ALARP Demonstration Work Process: Risk Based Approach



Safety Critical Control Measures are:

- SIS
- PRV
- Critical Alarms
- Critical Procedures
- Critical Check Valves
- Others……..

* : Risk Rank based on Risk Matrix on slide 17

Recap

- **Safety Case Regime**: move to improve Process Safety in Singapore MHI's
- Use resource intensive SC development process to **drive improvement at your facility** by maximizing use of your in-house resources (knowledge retention!)
- ALARP demonstration is a process **not** an end goal
- Use different risk analysis tools based on **proportionality** to demonstrate risk at ALARP level
- **Semi-quantitative method** a reasonable tool for most well understood risk scenarios in MHI
- Use **resource intensive quantitative QRA and CBA** only for complex high risk scenarios
- **Maintain installed barrier health to ensure risk remains at ALARP level**

References

- Singapore MHD: Safety Case Technical Guidance
- Singapore MHD: Safety Case Assessment Guide
- UK HSE document: Guidance on ALARP Decision in COMAH
- UK HSE document: Reducing Risks Protecting People (R2P2)
- UK HSE Principles for Cost Benefit Analysis
- NOPSEMA Australia Guidance Note on ALARP

Safety Case Is A Journey,

A Journey to Safety Excellence!

Backup…..

Regulatory Requirements On ALARP

- **Singapore Safety Case Regime Technical Guidance:**
  - *"In a safety case, MHIs are required to show, through reasoned and supported arguments, that* ***all practicable control measures that can be reasonably implemented have been implemented to reduce the risk for SCEs*** *(i.e. all necessary measures). The adopted control measures for any identified SCE shall be shown to collectively eliminate or reduce the risk to health and safety to ALARP levels…"* (section 308)

- Expectation On ALARP demonstration: Reduce identified risk from Safety Critical Events to **As Low As Reasonably Practicable**

ALARP

- **Safety Case regime Technical Guidance:**

  *"**Reasonable Practicability** – In the context of risk, practicability is whether a control measure can be implemented based on current technological capabilities. However, **sacrifices (in money, time and/or effort)** would bring into perspective the reasonableness of implementing a control measure. Hence, **determining whether SCE risks have been reduced to ALARP involves an assessment of risk to be reduced, an assessment of the sacrifice involved in implementing control measures to reduce that risk and a comparison of the two (risk reduced or avoided and sacrifice)**. The basis on which the comparison is made involves the test of '**Gross Disproportion**'"* (section 312)

ALARP

- **Safety Case regime Technical Guidance:**

  "Gross disproportion – When risks are reduced, there are benefits derived, such as safer workplace, no loss of lives and increased productivity. The benefits are a result of the risk reduction as sacrifice (i.e. a combination of money, time, effort, etc.) has been made to implement a control measure. When more sacrifices are made, the risk is reduced further. However, there is a point or region where any incremental sacrifice to implement more control measures does not derive significant additional benefit. At this point or region, risk reduction is considered ALARP and further measures to reduce the risk can be ruled out." (section 313)

Integration of Process Safety Management Elements for Safety Case

Lim Liang Hong
Occupational Safety & Health Division, Major Hazards Department
Ministry of Manpower

SCDF The Life Saving Force
MINISTRY OF MANPOWER
National Environment Agency Safeguard · Nurture · Cherish

Major Hazards Symposium
28 July 2017

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Presentation Agenda

- Singapore's PSM Journey
- Safety Case Regime
- WSH (SHMS & Auditing) Regulations
- Integration of SS506:Part 3 in Safety Case

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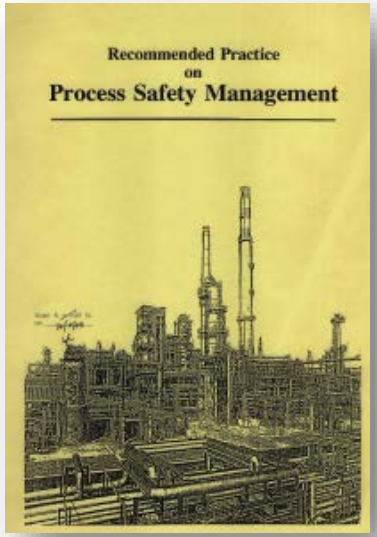
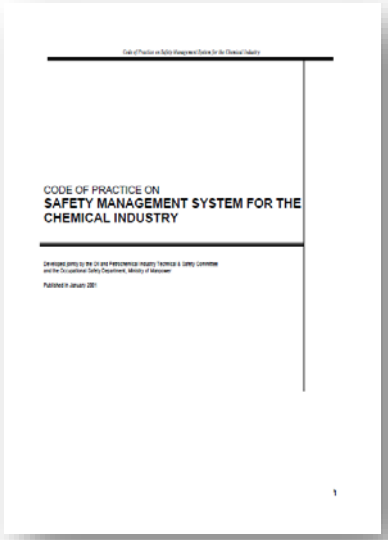
Singapore's Process Safety Management Journey

Modelled after OSHA Rule 1910.119 & API RP 750



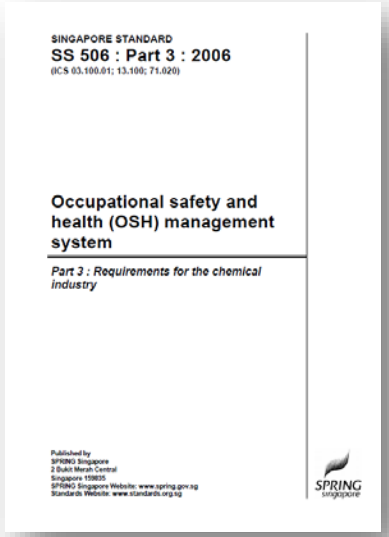
1993

14 elements, with PSM
Factories Act
Mandatory audits



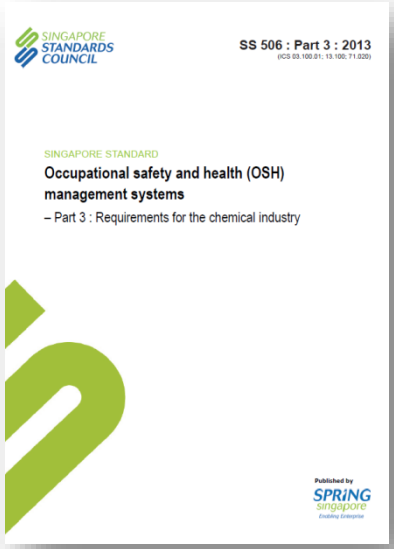
2001

CP on SMS for the Chemical Industry + OHSAS 18001



2006

Revised SS 506 : Part 3
Published Dec 2013



2013

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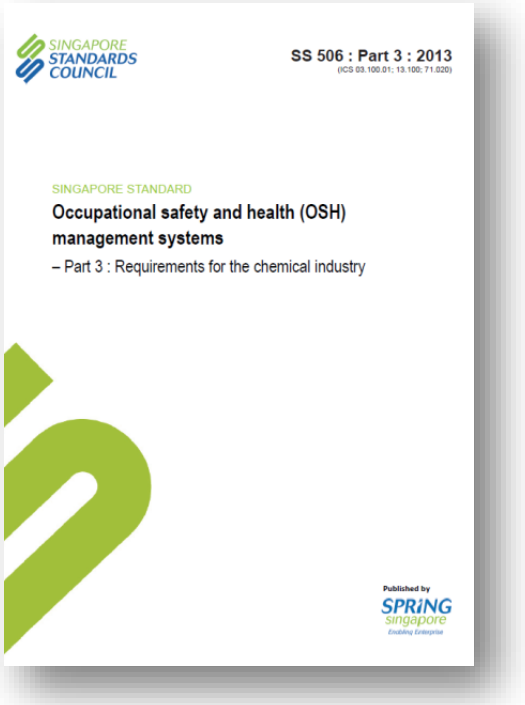
SS 506 : Part 3

- Enables a single management system satisfying both the OHSAS 18001 and the Code of Practice on SHMS for the Chemical Industry

- SS 506 : Part 3 adopts the framework of OHSAS 18001

- Enables requirements for certification for the chemical industry



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SS 506 : Part 3

- Amalgamation of PSM elements with that of OSH, arranged in a Plan-Do-Check-Act framework as in SS 506 Part 1 or OHSAS 18001

Process Safety Elements

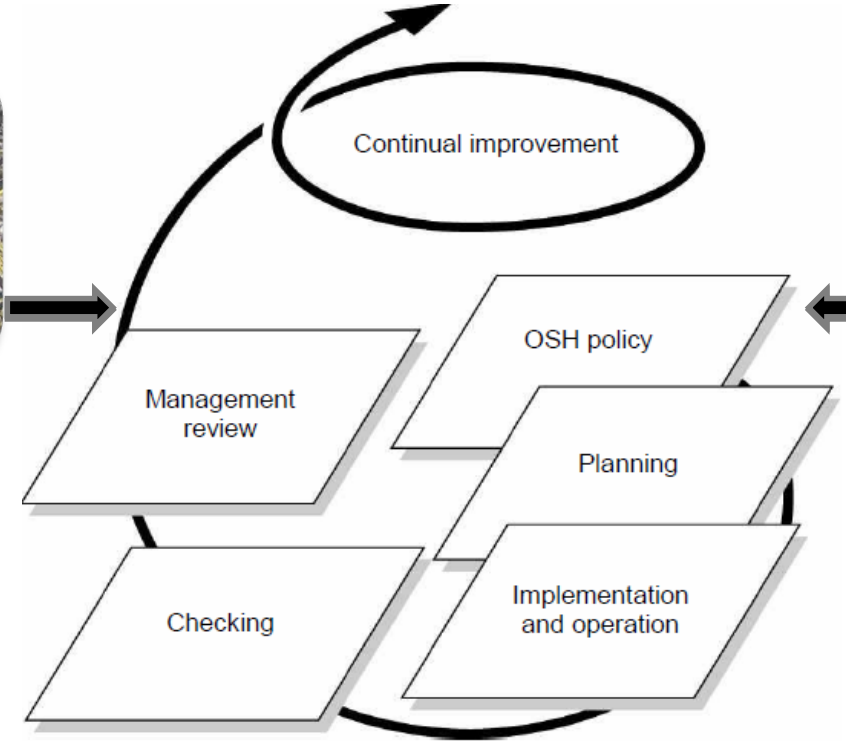

Figure 1 – OSH Management systems model

Occupational Safety & Health Elements

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SS 506 : Part 3

Process Safety Elements	
4.3.1.1	Process Safety Information
4.3.1.2	Hazard Identification, risk assessment and control of risks
4.4.2	Competence, training and awareness
4.4.6.2	Operating procedures and safe work practices
4.4.6.3	Management of change
4.4.6.4	Pre-Start-up Safety
4.4.6.5	Contractors
4.4.6.6	Mechanical integrity and reliability
4.4.6.7	Control of hazardous substances
4.4.6.8	Safety indicators
4.4.8	Emergency preparedness and response
4.5.3	Incident, investigation, nonconformity, corrective action and preventive action

Occupational Health Elements	
4.4.7.1	Medical surveillance
4.4.7.2	Hearing conservation
4.4.7.3	Respiratory protection

OSH Policy & Structure Elements	
4.2	OSH Policy
4.3.2	Legal and other requirements
4.3.3	Objectives and programme(s)
4.3.4	OSH management programme(s)
4.4.1.1	Structure, responsibility and authority
4.4.1.2	In-house OSH rules and regulations
4.4.3	Communication, participation and consultation
4.4.4	Documentation
4.4.5	Control of documents
4.5.1	Performance measurement and monitoring
4.5.2	Evaluation of compliance
4.5.2.3	OSH inspection
4.5.4	Control of records
4.5.5	Internal audit
4.6	Management review

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Progressing into Safety Case Regime

Around the World

In 2000s, there were a series of major hazards accidents with ***catastrophic consequences.***

Singapore

We also experienced some process-related incidents that could potentially escalate into ***major accidents.***

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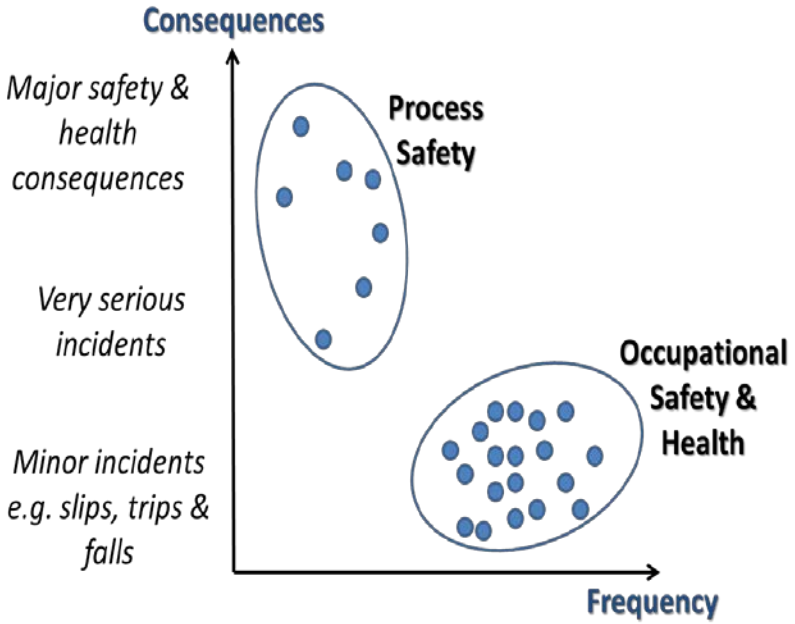
Progressing into Safety Case Regime

Process Safety vs. Occupational Safety

- There is an emerging need to place greater emphasis on process safety as process safety-related incidents could result in ***catastrophic consequences,*** as seen from major accidents in other parts of the world.

- Process safety is a disciplined framework for managing the integrity of hazardous operating systems and processes by applying good design principles, engineering and operating practices.



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Progressing into Safety Case Regime

- ***Growing number*** of installations in Singapore, coupled with greater process complexity and integration.
- To address the possibility of ***major accident*** occurrences.
- MHIs need to place greater emphasis on prevention of ***major accidents.***
- We believe in learning from past incidents and also from best practices in other established jurisdictions.

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Safety Case Regime

Intention:

To cover industrial installations which possess ***Major Accident Hazard***, to:

- Workforce
- Neighbouring communities

due to the quantities and nature of substances they handle.

Safety Case regime is effected through enactment of the Workplace Safety and Health (Major Hazard Installations) Regulations, under the WSH Act

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Safety Case Regime

Duty of **occupier** of the MHIs to take all measures necessary to reduce the risk of major accidents to ALARP* and to limit the consequences of major accidents.

* As Low As Reasonably Practicable

Minimum information required

- ✓ Major Accident Prevention Policy (MAPP) and **Safety & Health Management System (SHMS)**
- ✓ Description of installation and its vicinity
- ✓ Major Accident Hazard Identification, risk analysis and prevention methods
- ✓ Protection and intervention measures to limit consequences

Demonstrate in a Safety Case

Review of Safety Case

- Every 5 yearly or new fact or technical knowledge about safety & health matters
- When there are new information or changes to the **SHMS** which could have significant repercussions with respect to major accidents

What is a Safety Case (SC)?

Through **structured argument**, supported by a **body of evidence**, that provides a compelling, comprehensive and valid case that the MHI is safe for given application in a given operating environment.

Descriptive Info about MHI	MAPP & SHMS Focus on Major Accidents	Predictive Identification of Major accidents & Risk Assessment
Process Safety	Mechanical Safety	Electrical, Control & Instrumentation Safety
Human factors Safety critical task, roles and design	Emergency Response incorporating domino impacts	ALARP Gap analysis & demonstration

Account for the entire MHI Lifecycle

i.e. Design, Commission, Operation, Maintenance and Decommission

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Safety & Health Management System (SHMS)

- Key features of a SHMS are establishing a policy, linking objectives with this policy, making arrangements for delivering the policy / objectives and measuring performance.
- Intended to ensure that operations are directed, planned, conducted and controlled such that operation of the facility is safe.
- Represents top management's expectations for the people who manage and perform the business activities.
- Needs to be suitable and appropriate to the particular facility, used in practice, and must be reviewed and revised whenever the circumstances require.

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WSH (MHI) Regulations 2017

6. Subject to regulation 11(4), the occupier of a major hazard installation or deemed major hazard installation must implement the safety case for the major hazard installation or deemed major hazard installation by doing all of the following:

(a) Implement the major accident prevention policy for the major hazard installation or deemed major hazard Installation;

(b) ensure that the person mentioned in paragraph 1(b) of Part 2 of the Third Schedule carries out the roles and responsibilities specified in that paragraph;

(c) implement the plan mentioned in paragraph 1(d) of Part 2 of the Third Schedule;

(d) implement the safety and health management system in accordance with the Workplace Safety and Health (Safety and Health Management System and Auditing) Regulations 2009 (G.N. No. S 607/2009)

(e) ensure that the necessary resources, mentioned in paragraph 3 of Part 2 of the Third Schedule, are available for implementing the major accident prevention policy;

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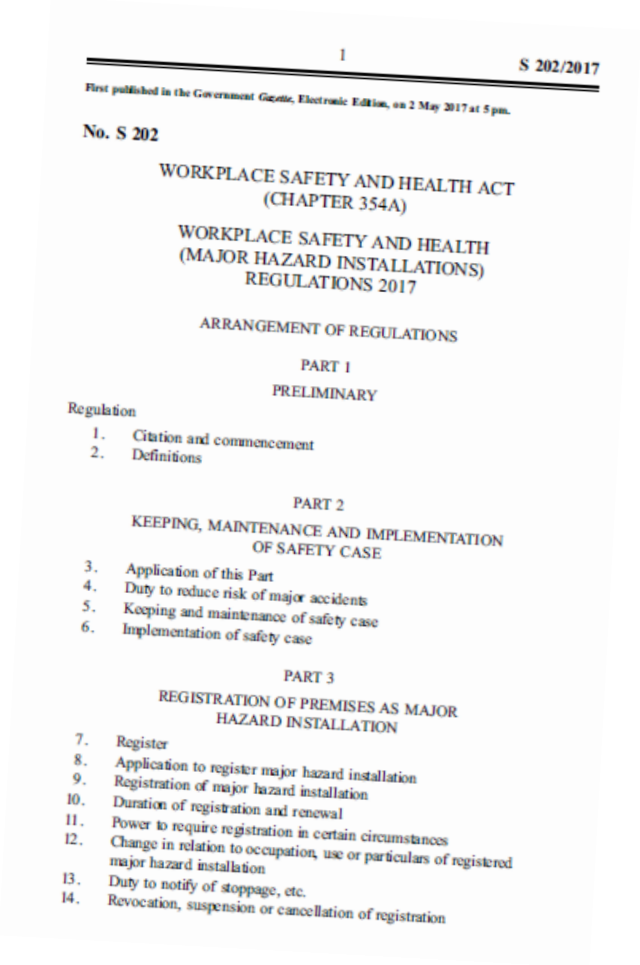
WSH (MHI) Regulations 2017

17. – (3)

Despite paragraphs (1) and (2), the occupier of a registered major hazard installation must review the safety case whenever –

(c) the occupier makes a change to the safety and health management system that has a significant impact on the prevention of a major accident or the limitation of consequences of a major accident.



1 S 202/2017

First published in the Government Gazette, Electronic Edition, on 2 May 2017 at 5 pm.

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

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WSH (SHMS & Auditing) Regulations 2009

- Occupier of MHIs shall have the safety and health management system **independently** audited at least once every 24 months.
- MHIs have to demonstrate how they ensure that the Safety Management Systems remain relevant and effectively implemented
- MHIs shall notify MHD of any changes / audit findings that have significant impact on the prevention of a major accident of limitation of consequences of a major accident.

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Chapter 3: MAPP & SHMS

- SHMS described in the Safety Case shall cover the elements of SS 506: Part 3.
- Not necessary to describe entire SHMS, but need to justify an effective and adequate SHMS is in place.
- Demonstrate elements in SHMS that are effective for preventing **Major Accidents** or limiting the consequences for people.
- Amount of details shall be proportionate to the nature of the MAHs identified.
- MHIs also need to put in place an auditing scheme.

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Chapter 3: MAPP & SHMS – cont'd

- MHIs may use their own SHMS model.
- In-house SHMS shall be at least meet the intents of the elements covered in SS506: Part 3.

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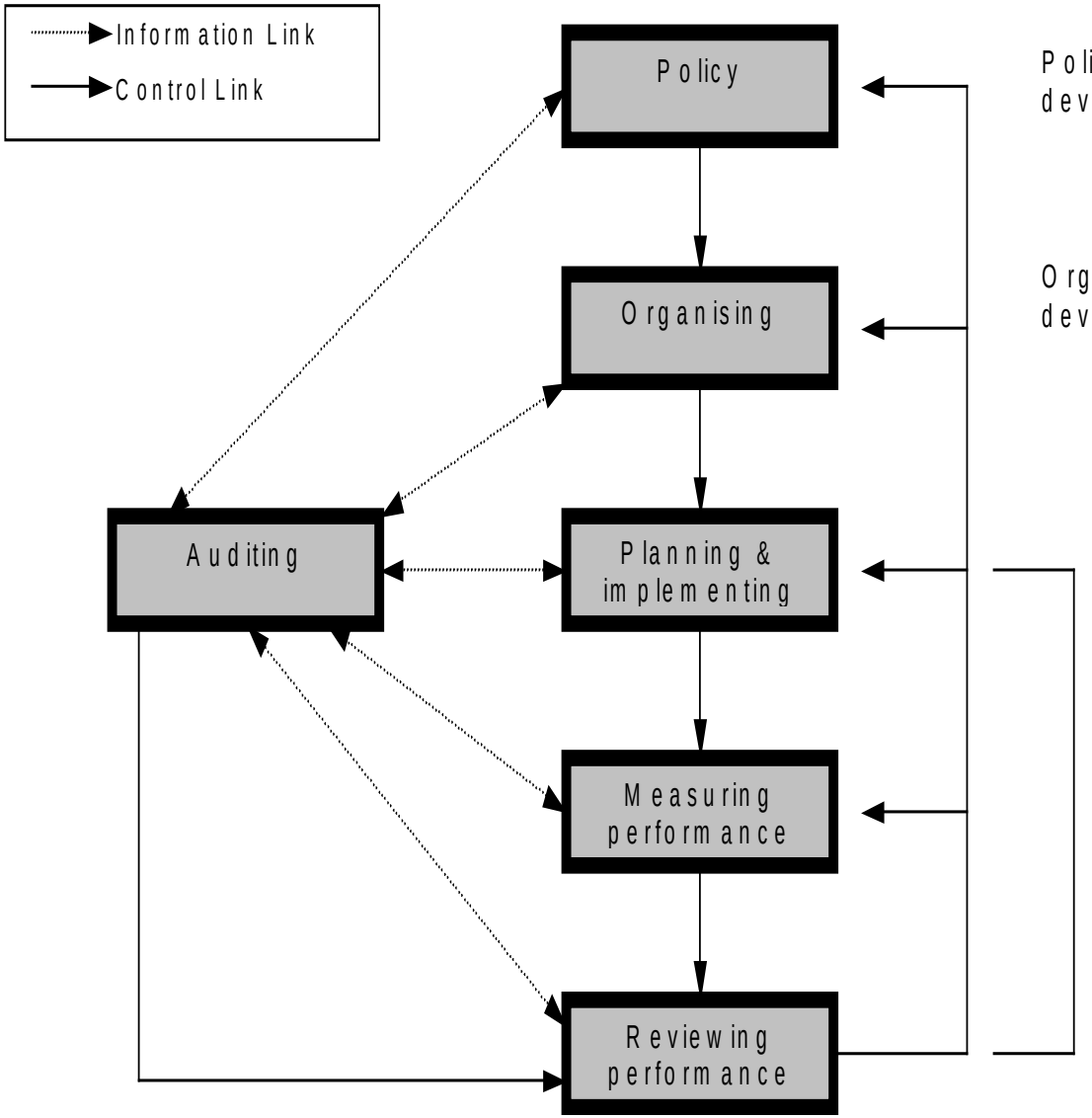
Integration of PSM Elements



HSE (1997) Successful Health and Safety Management HS(G)65, ISBN 0717612767

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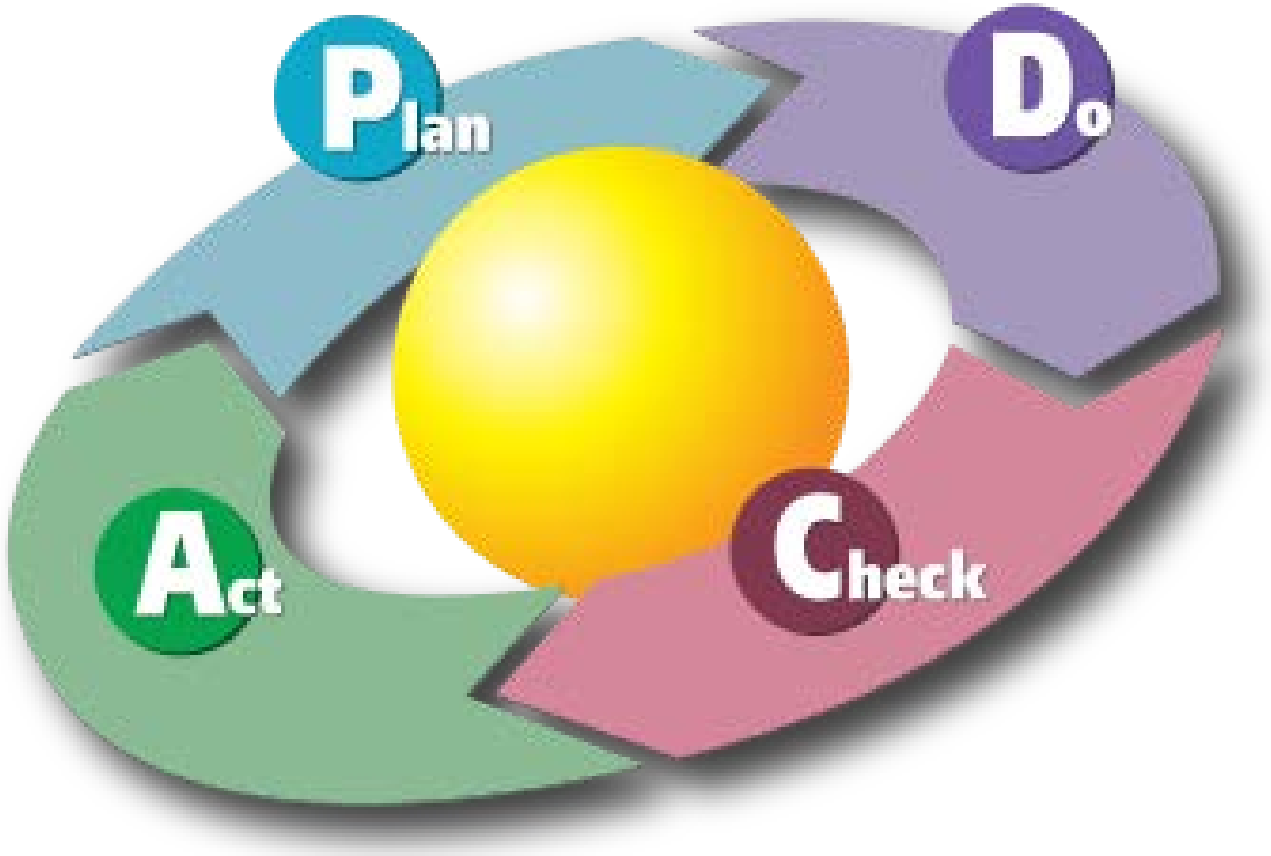
Integration of PSM Elements – cont'd



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Integration of PSM Elements – Key Focuses

POLICY ("PLAN")

- Major Accident Prevention Policy (MAPP) – Provide statement of senior management's commitment to achieve high standards of MAHs control and process safety performance.
- Lay down the framework for achieving adequate identification, prevention, mitigation of MAS and demonstrate commitment to continual improvement.

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Integration of PSM Elements – Key Focuses

ORGANISATION ("DO")

- Roles and Responsibilities
- Resources
- Personal Performance
- External Organisation

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Integration of PSM Elements – Key Focuses

PLANNING & IMPLEMENTATION ("DO")

- Worker Participation
- Information Gathering
- Internal Communication
- Priorities for Improvement
- Procedures
- Management of Change

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Integration of PSM Elements – Key Focuses

MEASURING PERFORMANCE & AUDIT ("CHECK")

- Active Monitoring
- Reactive Monitoring
- Investigation and Response
- Audit

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Integration of PSM Elements – Key Focuses

REVIEWING PERFORMANCE ("ACT")

- Review
- Documenting the Review

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In Summary…

- The SHMS described in the Safety Case shall cover the elements of SS 506: Part 3.
- The SHMS shall demonstrate effective prevention of Major Accidents or limiting the consequences for people.
- Integration of PSM elements can be achieved through a Plan – Do – Check – Act cycle

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Thank You!

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Strengthening Safety Cases

Mr Anthony Woo

28th July 2017

Strengthening Safety Cases

Piper Alpha disaster 6 July 1988 - 167 fatalities

Source: Clip Art

Strengthening Safety Cases

"Safety is not an intellectual exercise to keep us in work. It is a matter of life and death. It is the sum of our contributions to safety management that determines whether the people we work with live or die."

Sir Brian Appleton

Sir Appleton is one of safety assessors at the Piper Alpha disaster

Strengthening Safety Cases

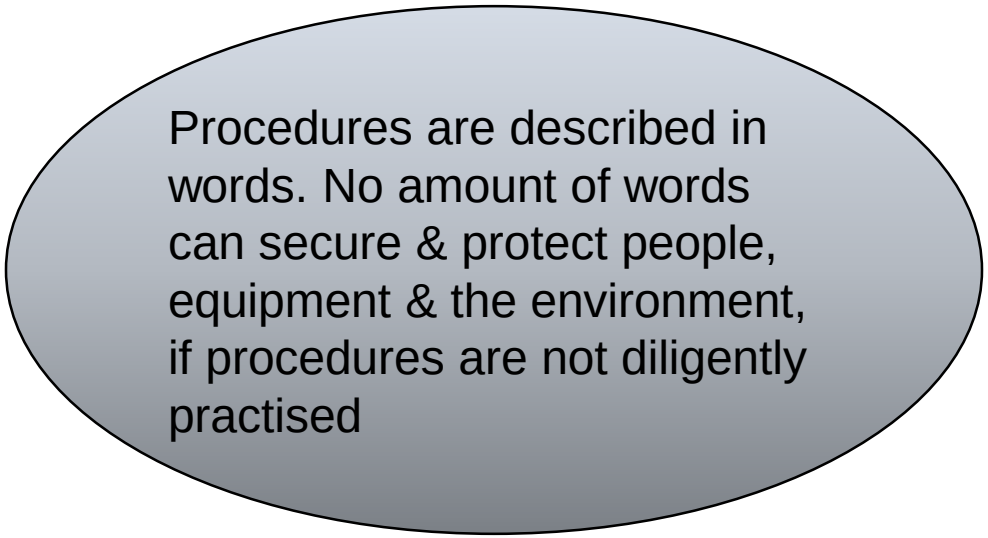
Quote:

... no amount of regulations for safety improvements can make up for deficiencies in the way that safety is actually managed...' Unquote

Lord Cullen reporting in Piper Alpha Disaster Inquiry

Strengthening Safety Cases

Procedures which also incorporate rules & regulations in work processes are critical in strengthening safety cases



Strengthening Safety Cases

Procedures (as these have been written)

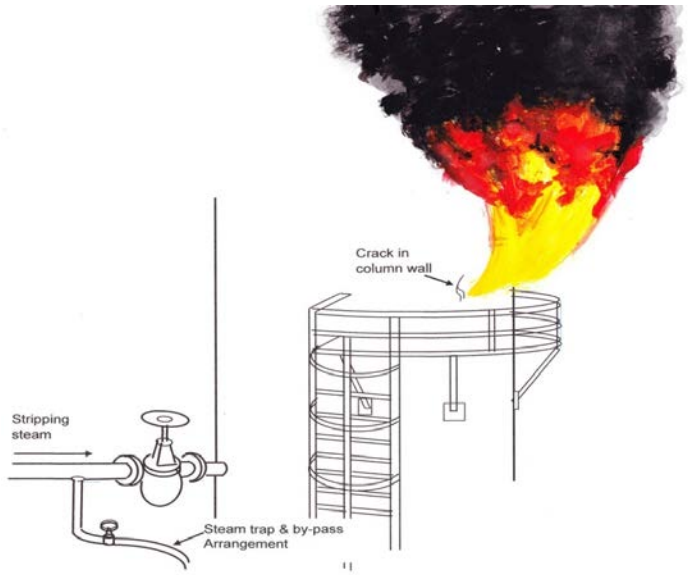
- A procedure is a set of steps leading to job completion
- Different methods and styles in writing procedures
- Written by supervisors & issued to employees

Procedures although low in the control hierarchy are nevertheless critical risks if these are not applied knowledgeably & correctly

Risk Control Hierarchy

Consequences of Failed Procedures

Failure to warm up steam line according to procedures



Fire due to cracked column wall

Broken turbine wheel

Procedures

- Procedures not followed undermine all risk control intentions, e.g.
  - Instrument safeguarding malfunction due to omission in maintenance
  - Automation function over-ridden for extended time duration, or forgotten
- Procedures fail due to various reasons
  - All due to people
  - Lack of knowledge
  - Taking short cuts, etc

How can we make procedures ‘fool proof?’

Making Procedures Fool Proof

Additional to *good practices* in procedure writing

- Transfer ownership to stakeholders
- Involve employees in writing, they know best
- Employees identify critical steps & control essentials
- Reduce risks at source by incorporating controls in work activities

Good procedure writing

- ✓*Use standard format*
- ✓*Aim simple & concise*
- ✓*Write unambiguous steps*
- ✓*Use command verbs*
- ✓*Highlight hazard effects*
- ✓*Use graphics or flow chart*
- ✓*Test out draft procedures*
- ✓ *Improve & finalise*
- ✓*Issue for mandatory use*
- ✓*Assign owner for continual maintenance*

Making Procedures Fool Proof

- All steps in a procedure must have definable outcomes
  - Measured values, e.g. temperature, pressure, quantity
  - Confirmation of deliverables by beneficiary or supervision

Procedures are prescribed for all activities, but nothing achieves the desired output except diligence and the senses of 'doing right the first time at all times'.

- Record status of outcomes in hard copy or electronic form
- Outcomes must leave an audit trail
- Procedures provide the link to shift log documentation

Making Procedures Fool Proof

Examples of definable outcomes

- Warming up steam line before introducing steam into column or turbine

1) Open drain valve at end of steam line for draining condensate
2) Open steam in incremental steps to gradually warm up steam line over 30 mins.
3) Check temperature of steam line every 10 mins to ensure gradual increase to within 10°C of normal operating temperature.
4) Check condensate being drained to confirm line is clear of condensate. *Link to hazard effects*

- Steam temperature increase can be tracked & recorded manually or electronically
- Hazard impact is accessible through a link for training & TBM before job commencement

Hazard effects of steam

Water hammer

- Water hammer is caused by shock waves when high-pressure steam is introduced and acted on condensate in a pipeline
- Energy release by the shock waves can cause pipe rupture & equipment damage, injuring personnel

Hazard control during start up of steam system

- Pipe lines must be warmed up gradually to avoid
  - Water hammering
  - Undue & uneven expansion stress resulting in leaks

PPE

- Protect against contact especially if getting into the path of a leak, e.g.
  - Face shield
  - Leather gloves
  - Work clothes, may also include leather apron if venting steam
  - Hearing protection against noise from steam venting

Making Procedures Fool Proof

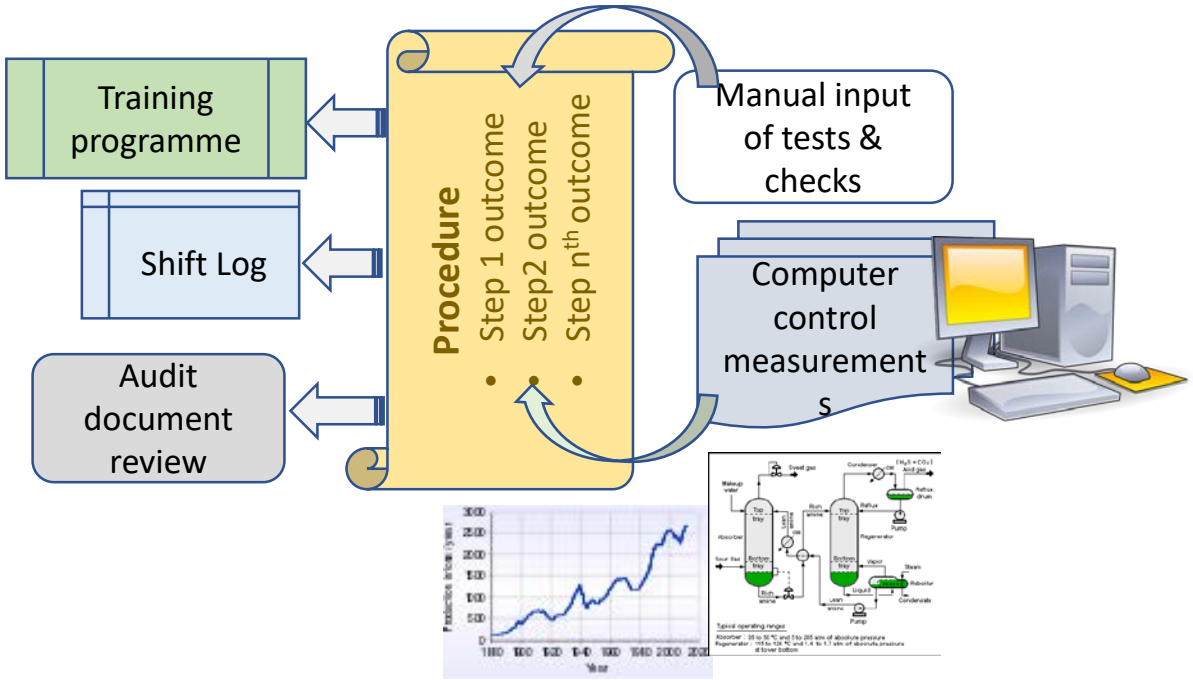
Example of PTW

- Procedure identifies specific steps such as
  - Apply for approval to carry out described work
  - Identify hazards & assess risks work can cause
  - Incorporate hazard control into work method
  - Prepare equipment to allow work as determined in risk assessment
  - Prepare site to ensure safety and occupational health protection, as determined in risk assessment
  - Perform gas test and site inspection and record results
  - Report findings to authorised manager & obtain his/her approval to commence work
- All steps as described above will have outcomes recorded in the PTW

Recording outcomes of procedure steps

- Both examples must have procedures electronically maintained
- Outcome from each procedural step will
  - Either be manually recorded or
  - Defaulted from plant computer control measurements
- For start up or shut down, plant conditions responding to procedure steps are captured & compared with planned outcomes
- Control parameters are set & built into the procedure to allow or withhold following steps
- Recording provides the reference for shift hand-over & audit trails

In a nut shell



thank
you!

Education on Process Safety

Lim Kok Hwa

28 July 2017

Future Challenges

THE CASE OF THE

vanishing mid-level skilled worker

Source: The Straits Times (29 Mar 2014)

As automation advances, jobs for middle-skilled workers are disappearing. Insight looks at the issue of job polarisation and what might lie ahead for Singapore's labour force.

Jobs that are routine and predictable will disappear

- **Jobs more specialised or need better people skills or both**

Challenges

Changes to MHI Regulatory Framework

- Safety Case regime will take effect on 1 September 2017 through the WSH (MHI) Regulations
- MHIs are required to show that adequate, effective and reliable control measures are in place to reduce risks of major accidents to "as low as reasonably practicable" (ALARP)
- MHIs are so integrated in their operations across different companies, MHIs will be obliged to share critical information on the nature and extent of risks on affected workplaces
- MHIs will be required to notify and report process-related incidents. This will enhance safety standards through learning from past incidents and best practices in the industry

Request from Industry

- need to build technical know-how of MHI personnel for this new regime
- ensure that competent personnel continue to upskill
- systematic training framework to ensure harmonised skills for competent personnel

Development of Process Safety Workshop Series with Pfizer

- **Specialist Certificate in Process Safety** comprises the following 8 workshops
  - Workshop 1 – Process Safety Concepts
  - Workshop 2 – Fire and Explosion Prevention
  - Workshop 3 – Design & Engineer For Safe Operation
  - Workshop 4 – Relief Systems Type and Characteristics Design Consideration
  - Workshop 5 – Process Hazard Analysis
  - Workshop 6 – Layer of Protection Analysis
  - Workshop 7 – Human Factor in Process Safety
  - Workshop 8 – Quantitative Risk Assessment

Sharing of Workshop Series to Pharmaceutical Industry and Beyond

- MSD
- Shared initiative with process safety communities of the pharmaceutical Industry with further responses from Amgen, Sanofi, etc.
- Supported through funding from e2i
- Discussion with MOM's OSH Specialist Department and commented that it is one of the way to help up-skill the industry
- Requested to launch workshop series to benefit industry (supported by NTUC and e2i)

Key Features – Applied Learning

Classroom Knowledge

Conduct Plant Walk Through

Hazard Evaluation

Case Study

Hands-on Exercise

Severity \ Likelihood	1	2	3
1	Low	Low	Medium
2	Low	Medium	High
3	Medium	High	High

Risk Assessment

Support from Top Management

Opening speech

Workshop 1 was successfully conducted on 26 October 2016 with participants from Pfizer, MSD, Amgen and Sanofi

VIP: Mr Kenneth Bradley, VP, API Operations, Pfizer Global Supply

Key Features – Practice in Action

Safety briefing before workshop

Work with industry partners to host workshop as far as possible to include plant walk through for application exercise

Safety briefing by Mr Teng Chong Seng, EHS Team Leader, Pfizer before plant walk through

Key Features – Case Studies

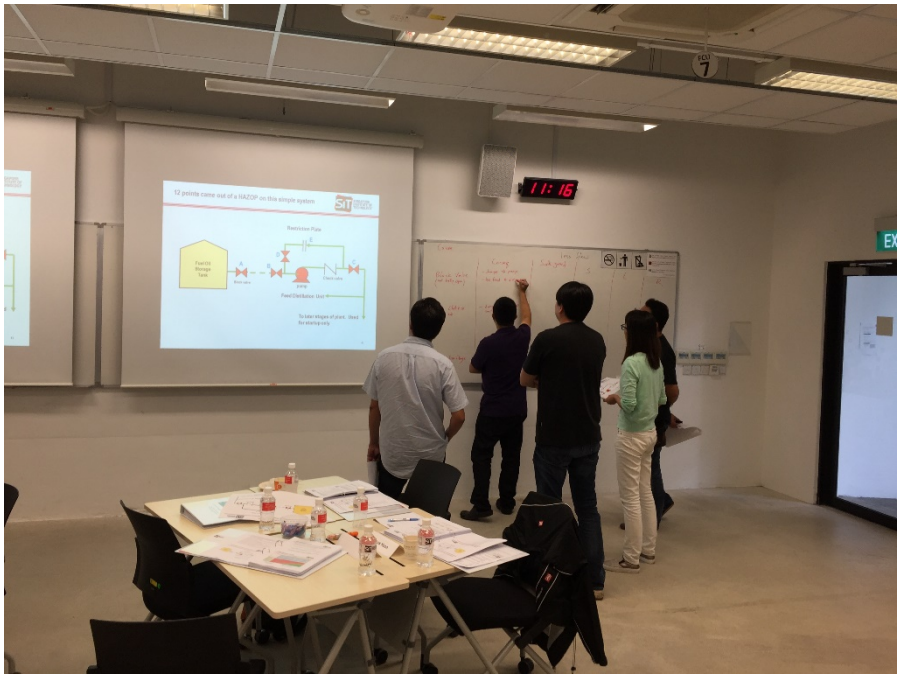
Discussion over lunch for application exercises

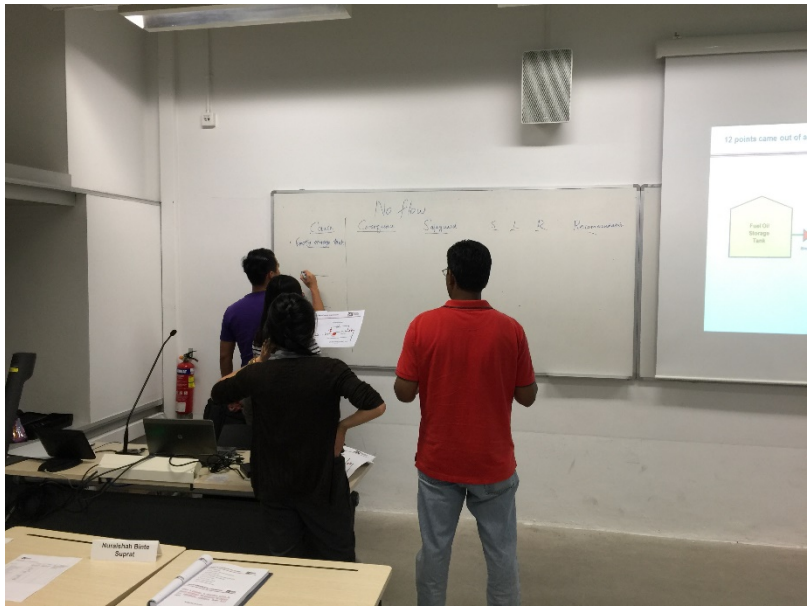
Case study for application exercises

Participants from MSD actively taking down notes during the workshop

Key Features – Hands-on Exercise

Workshop held in MSD with plant walk through





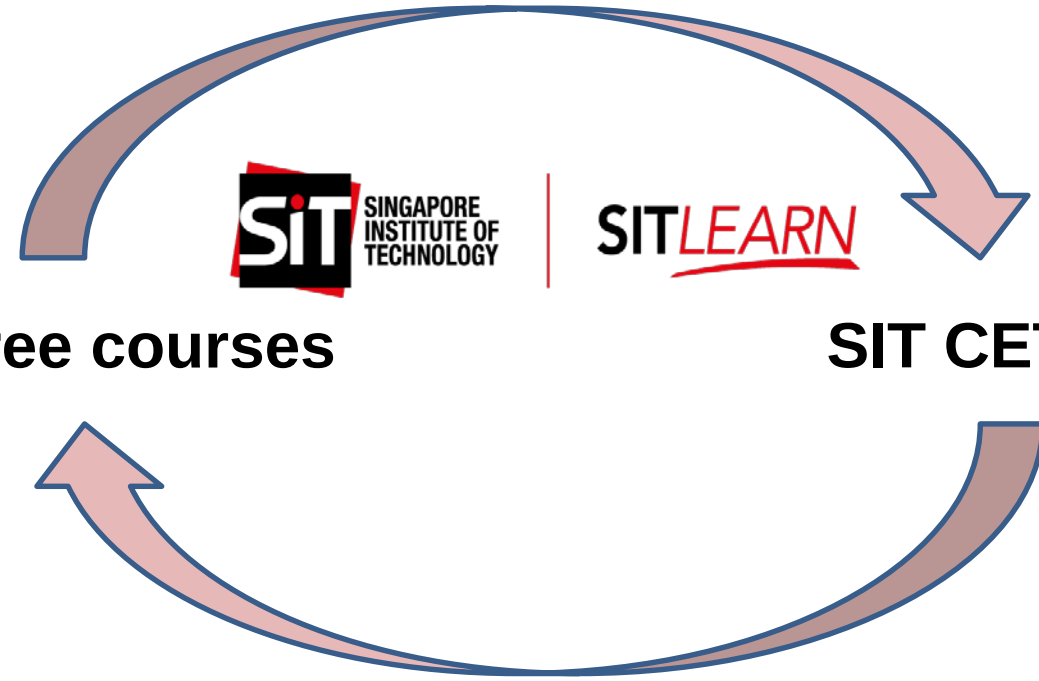
Case Study Discussion by participants

Key Features - Assessment

- Quiz during workshop
- Case Study/ Hands-on exercises
- Portfolio (write-up on how the participant is able to apply the materials taught in their work) submission within 2 months of workshop + interview if necessary

Future-Proof Tomorrow Engineers

Meet industry needs through applied learning pedagogy



Reinforce UG programmes by incorporating industry feedback on the current gaps

Upcoming Courses

- Workshop 1 – **Process Safety Concepts**
  - 20 Nov 2017
- Workshop 2 – **Fire and Explosion Prevention**
  - 21-22 Nov 2017
- Workshop 3 – **Design & Engineer For Safe Operation**
  - 21-22 Aug 2017 & 16-17 Nov 2017
- Workshop 5 – **Process Hazard Analysis**
  - 23-24 Aug 2017 & 12-13 Oct 2017
- Workshop 6 – **Layer of Protection Analysis**
  - 16-17 Oct 2017

SINGAPORE INSTITUTE OF TECHNOLOGY

Thank you

Safety Case Regime: Closing Remarks

Jaime Lim
Acting Deputy Director
Major Hazards Department (MHD), OSHD

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Presentation Outline

WSH (MHI) Regulations

- Notification & reporting of process-related Incidents
- Provision of Information

Safety Case Submissions

Building Safety Case Capability

Closing Remarks

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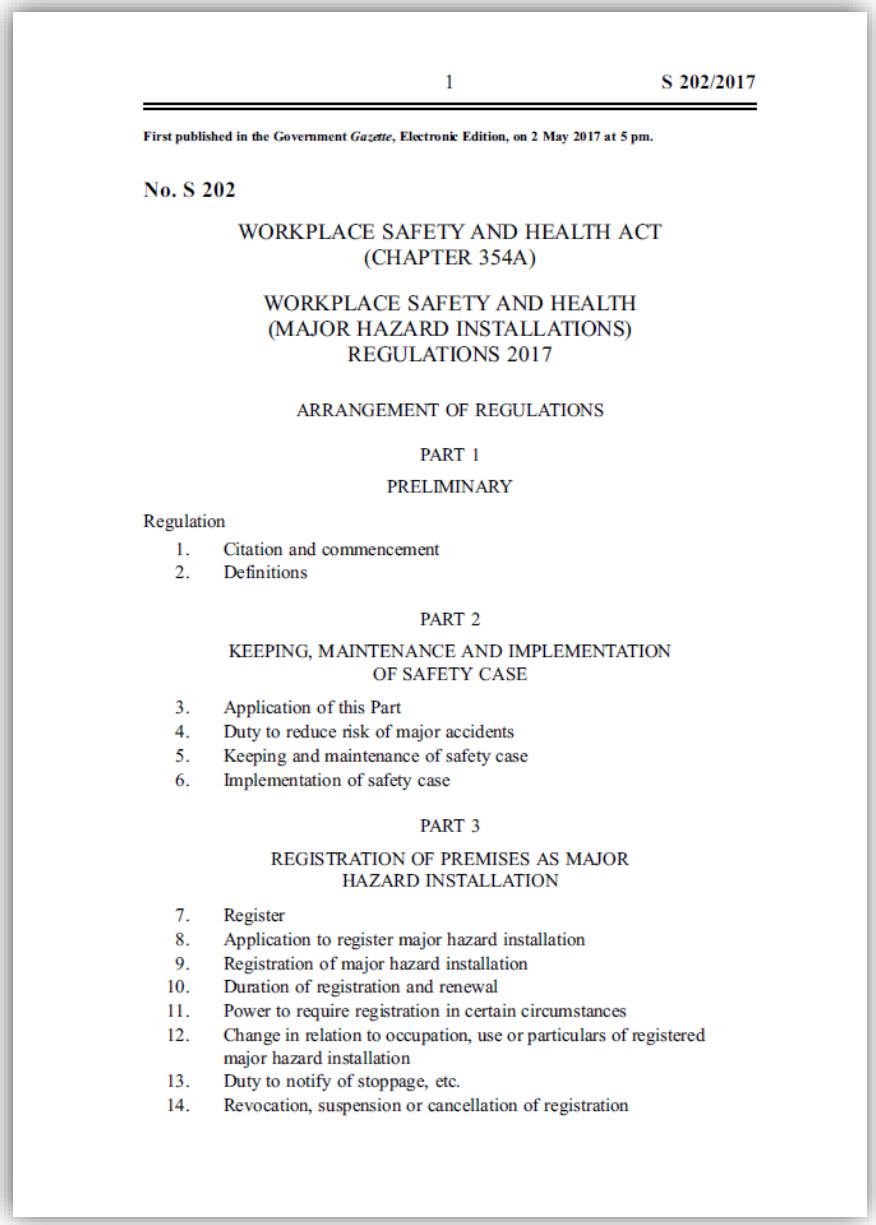
WSH (MHI) Regulations



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No. S 202

WORKPLACE SAFETY AND HEALTH ACT
(CHAPTER 354A)

WORKPLACE SAFETY AND HEALTH
(MAJOR HAZARD INSTALLATIONS)
REGULATIONS 2017

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13. Duty to notify of stoppage, etc.
14. Revocation, suspension or cancellation of registration

- Gazetted 2 May 2017
- Safety Case regime for Major Hazard Installations (MHIs) to take effect from 1 Sep 2017
  - ➢ as announced by MOS Sam Tan at 20 Oct 2016 MHI Symposium

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Process-related Incidents

Purpose of notifying and reporting process-related incidents:

- Timely investigations for interventions, including legal actions, if any
- Incident trending analysis and proactive stakeholder engagements

MHD's key considerations:

- Consistent approach for incidents to be reported to MHD
- Level of reporting does not overburden industry
- Enhanced streamlining of work processes among 3 regulators

"process-related incident" means an incident that occurs in connection with an activity involving one or more dangerous substances, including their use, storage, manufacturing, handling, on-site movement or distribution, or a combination of these activities, resulting in —

(*a*) an unintended explosion or fire causing damage to property, death or bodily injury to a person; or

(*b*) an unplanned or uncontrolled discharge of one or more dangerous substances,

and includes a major accident;

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Process-related Incidents

- **Notification** and **reporting** criteria for process-related incidents based on:
  - List of Dangerous Substances in MHI Regs
  - American Petroleum Institute's Recommended Practice 754 Process Safety Peformance Indicators for the Refining and Petrochemical Industries

- Reporting of accidents, dangerous occurrences, occupational diseases and process-related incidents (API 754 Tier 1 and Tier 2) by MHIs
  - Via iReporting on MOM's website

- Streamlined reporting for MHIs to MOM, NEA and SCDF

06 2016年10月21日 星期三 联合早报 新加坡

新条例明年9月生效

发生高风险事故须通报人力部

由人力部、环境局及民防部队组成的高风险设施管理部门将成为量交定量风险评估报告的协调中心，更全面地进行安全评估及事故调查等工作。

宋慧纯 报道 hcsong@sph.com.sg

工作场所安全与卫生（高风险设施）条例明年9月起生效，届时这些设施若是发生爆炸、火患等事故，业者都必须上网向人力部通报。透过该条例落实的新安全案件制度也能让相关机构人员更全面地进行安全评估及事故调查等工作。

人力部承总理公署政务部长陈振泉昨早主高风险设施（Major Hazard Installations，简称MHI）座谈会上说得时，透露了上述条例的一些细节。

为了落实安全案件制度（Safety Case Regime），人力部今年9月起成立由人力部、国家环境局及新加坡民防部队人员组成的高风险设施管理部门（Major Hazards Department，简称MHD）。

来自上述三个机构的人员将合作取代原本由民防部队及裕廊集团（JTC）领导的安全与风险管理中心，成为呈交定量风险评估（Quantitative Risk Assessment）报告的协调中心。

避免让邻业者被大型事故骨牌效应影响

在工作场所安全与卫生（高风险设施）条例下，需使用高风险设施的业者也需提呈这些工作场所存在的风险等关键资料。例如，业者可能需与比邻业者分享大型事故的规模及严重性，还有可能发生的潜在场外风险（off-site risk）。

陈振泉说，这是为了确保比邻业者有实施足够的措施保障自身的界运，不被大型事故可能产生的"骨牌"效应影响。他也说，"业务也必须证明工作场所有足够、有效及可靠的管制措施，将大型意外的风险减至'在合理且实际可行条件下的最低水平'"。

包括污化工业及有毒或易燃物质设施

高风险设施包括化学加工厂、石油提炼设施、石油化工制造设施及需要储存或使用大量有毒或易燃物质的设施。

明年9月起生效的新条例是在二作场所安全与卫生法令（Workplace Safety and Health Act）下制订，将影响需使用上述设施的行业。

陈振泉也透露，人力部、环境局及民防部队过去18个月来也与业内伙伴合作，同新加坡化学工业理事会开了超过50次会议，制定了安全案件技术指南及安全案件评估指南，协助业内人士更好地了解如何达到安全案件制度标准。

陈振泉说："虽然高风险设施发生事故的可能性一般来说很低，但后果可能惨重。确保高风险设施有健全的安全制度至关重要，不但攸关经济，也攸关民众及相关行业员工的安危。"

工作场所安全与卫生学院也与裕加坡科技研究局（A*STAR）旗下的化学与工程科学研究院（简称ICES）签署了合作备忘录，双方未来将在研究、提供技术建议、培训、分析测试服务等方面进行合作。

新的安全案件制度明年9月落实后，将影响包括在裕廊岛上拥有石油化工制造设施、石油提炼设施等高风险设施的业者。届时，他们将必须遵守新条例。德工作环境更安全。（档案照片）

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Process-related Incidents

Tier 2 Indicator Definition and Consequences

A Tier 2 Process Safety Event (T-2 PSE) is a LOPC with lesser consequence. A T-2 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g. steam, hot condensate, nitrogen, compressed CO_2 or compressed air), from a process that results in one or more of the consequences listed below and is not reported in Tier 1:

Note: Non-toxic and non-flammable materials (e.g. steam, hot water, nitrogen, compressed CO_2 or compressed air) have no threshold quantities and are only included in this definition as a result of their potential to result in one of the other consequences.

— an employee, contractor or subcontractor recordable injury;

— a fire or explosion resulting in greater than or equal to $2,500 of direct cost to the Company;

— a PRD discharge to atmosphere whether directly or via a downstream destructive device that results in one or more of the following four consequences:

  — liquid carryover;

  — discharge to a potentially unsafe location;

  — an on-site shelter-in-place;

  — public protective measures (e.g. road closure);

  and a PRD discharge quantity greater than the threshold quantity in Table 2[5];

— a release of material greater than the threshold quantities described in Table 2 in any one-hour period.

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Process-related Incidents

Table 2—Tier 2 Material Release Threshold Quantities

Threshold Release Category	Material Hazard Classification [a,c,d]	Threshold Quantity (outdoor release)	Threshold Quantity (indoor[b] release)
1	TIH Zone A Materials	0.5 kg (1.1 lb)	0.25 kg (0.55 lb)
2	TIH Zone B Materials	2.5 kg (5.5 lb)	1.2 kg (2.8 lb)
3	TIH Zone C Materials	10 kg (22 lb)	5 kg (11 lb)
4	TIH Zone D Materials	20 kg (44 lb)	10 kg (22 lb)
5	Flammable Gases or Liquids with Initial Boiling Point ≤ 35 °C (95 °F) and Flash Point < 23 °C (73 °F) or Other Packing Group I Materials excluding strong acids/bases	50 kg (110 lb)	25 kg (55 lb)
6	Liquids with a Initial Boiling Point > 35 °C (95 °F) and Flash Point ≤ 60 °C (140 °F) or Liquids with Flash Point > 60 °C (140 °F) released at or above Flash Point; or Other Packing Group II and III Materials excluding moderate acids/bases or Strong acids and bases	100 kg (220 lb) or 1 bbl	50 kg (110 lb) or 0.5 bbl
7	Liquids with Flash Point > 60 °C (140 °F) released at a temperature below Flash Point or Moderate acids/bases	1000 kg (2200 lb) or 10 bbl	500 kg (1100 lb) or 5 bbl

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Provision of Information

Purpose: Manage domino impacts

Based on MHIs' Safety Cases, MHD will designate MHIs into groups for provision of info

The info exchange should allow the affected party to understand:

- Potential hazards and major incidents from MHI neighbour, which could affect equipment and personnel
  - A release at a neighbouring MHI renders an evacuation route inaccessible
  - An explosion at a neighbouring MHI that could damage control room or fire systems
- Potential hazards which could result in a major incident at affected party's facility
  - A fire at a neighbouring MHI may cause another fire at affected party's equipment located near fenceline
- Control measures on the affected party's site that may reduce risk from event at MHI neighbour's facility
  - Isolation of shared lines
  - Provision of mutual aid

MHD's key considerations:

- Info shared must be sufficient for other MHIs to revalidate adequacy of their risk control measures, update emergency response plan and fully document external domino risks
- Sharing of info* should not cause any unnecessary alarm among neighbours
- Broad principles on provision of information will be stated on MHD's website

** Other jurisdictions such as UK & Australia do not seem have legal issues due to provision of info*

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Provision of Information

- ✓ **To require 20kW/m², 4kW/m², 2psi, LFL harm footprints for whichever harm levels that impact MHIs in the designated group**

  Specific harm footprints that affect that neighbour is shared with them. Other neighbours need not receive the same type of information if it is not applicable to them.

- ✓ **For MHIs that have conducted QRAs based on the previous Guidelines, it is suggested that interpolation factor of 0.8 could be used for thermal radiation and 0.6 for overpressure**
- ✓ **Overfilling scenarios to be included**

Harm levels	Interpolation factors / distance
20 kW/m²	0.8 using distance of 4kW/m² as reference
2psi	0.6 using distance of 1 psi as reference
Overfilling scenario 2psi	400 metres based on revised QRA guidelines

- ✓ **MHD will share interpolation factors on MHD's webpage**

Facilitating the sharing of info:

- ➢ **MHD will facilitate some pilot meetings if requested by the companies involved or if MHD foresees potential issues which would be raised during the meeting**

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Safety Case Submissions

- 4 phases – Pilot, Phases 1, 2 and 3
- Additional phase – Phase 3+
  - Lower risk or newly identified MHIs slated for Phase 3+ (e.g. power plants, chemical warehouses)
  - 1st engagement of workplaces in Phase 3+ conducted on 10 Apr 2017

Phase	Pre-receipt	Submission	Safety Case Acceptance by
0 (pilot)	Mar 2017	Sep 2017	Mar 2018
1	Sep 2017	Mar 2018	Sep 2018
2	Mar 2018	Sep 2018	Mar 2019
3	Sep 2018	Mar 2019	Sep 2019
3+	Mar 2019	Sep 2019	Mar 2020*

* The WSH (MHI) Regulations require all existing workplaces identified as an MHI to obtain an MHI Registration by the dates as determined by Commissioner, but not later than 31 Aug 2022.

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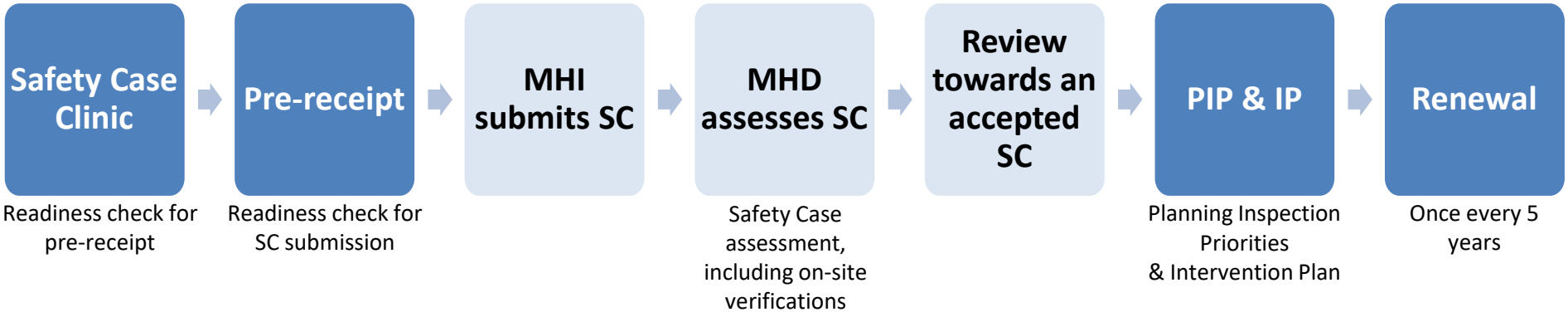
Safety Case Submissions

General work process:



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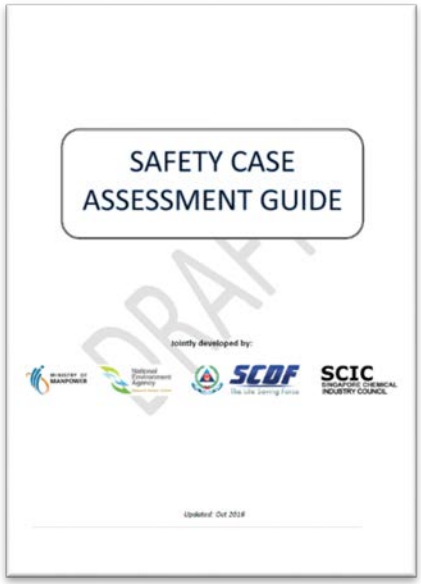
Building Safety Case Capability



- Co-developed with industry representatives in the Joint Work Group (JWG)
- Safety Case Technical Guide (TG) and Safety Case Assessment Guide (AG) published in Oct 2016
- Both TG and AG have been finalised

http://www.mom.gov.sg/workplace-safety-and-health/major-hazard-installations/preparing-safety-case

Building Safety Case Capability

- 4 Safety Case Knowledge-Building Workshops in 2016 conducted by MHD and JWG
- Organised by SCIC

Building Safety Case Capability

Safety Case Training Providers Recognised by MHD

MENU > Workplace safety and health > Major Hazard Installa... > Building capability for Saf... Search

Safety Case practitioner's training

Safety Case Leads (SCLs), or key MHI personnel, are responsible for preparing, implementing and operationalising Safety Cases. As such, SCLs should be equipped with the knowledge and skills to prepare Safety Cases for their organisations.

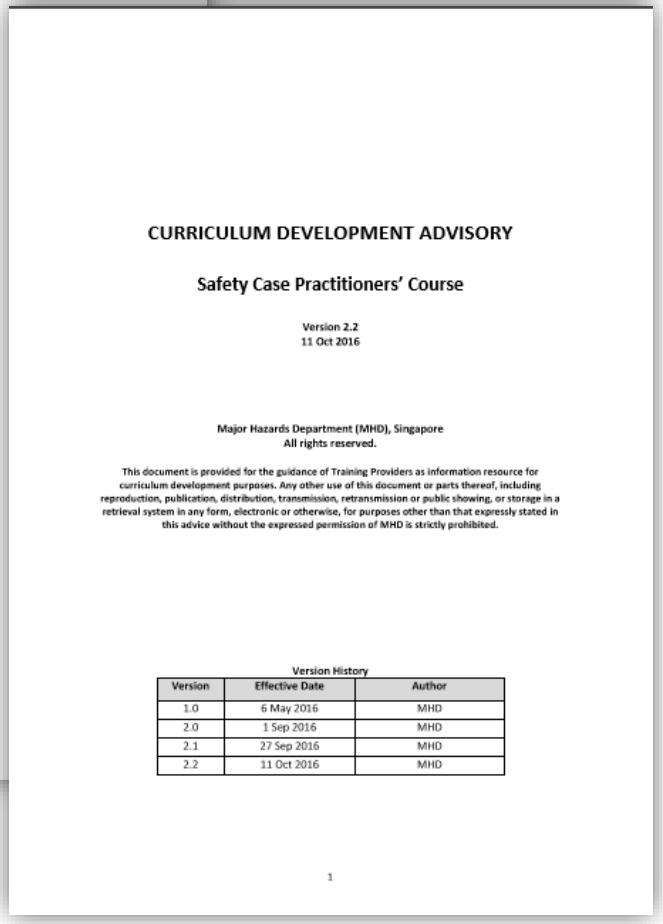
To learn how to prepare Safety Cases, SCLs could attend Safety Case practitioners' training by providers who offer training based on MHD's Curriculum Development Advisory.

> Tip
> Refer to the list of MHD-recognised training providers.

Apply to be Safety Case Training Provider

Organisations that wish to be recognised as Safety Case Training Providers will need to:

1. Download and complete the application form in the Curriculum Development Advisory.
2. Submit the application form and supporting documents:



CURRICULUM DEVELOPMENT ADVISORY

Safety Case Practitioners' Course

Version 2.2
11 Oct 2016

Major Hazards Department (MHD), Singapore
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Version History

Version	Effective Date	Author
1.0	6 May 2016	MHD
2.0	1 Sep 2016	MHD
2.1	27 Sep 2016	MHD
2.2	11 Oct 2016	MHD

1

http://www.mom.gov.sg/workplace-safety-and-health/major-hazard-installations/building-capability

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Closing Remarks

Predictive

- To recognise the feature of major accidents – low likelihood and grave consequences
- Upper bound for consequences is required
  - Consider on-site and off-site population
- Comprehensive selection methodology to focus on where it matters – SCEs
- Risk matrices used have to be sound, adequate and reflective of MHI's risk acceptance criteria
- Worst case scenarios for each frequency band to be selected as SCEs, otherwise, justify why not
- Illustrate with examples for each step in predictive methodology

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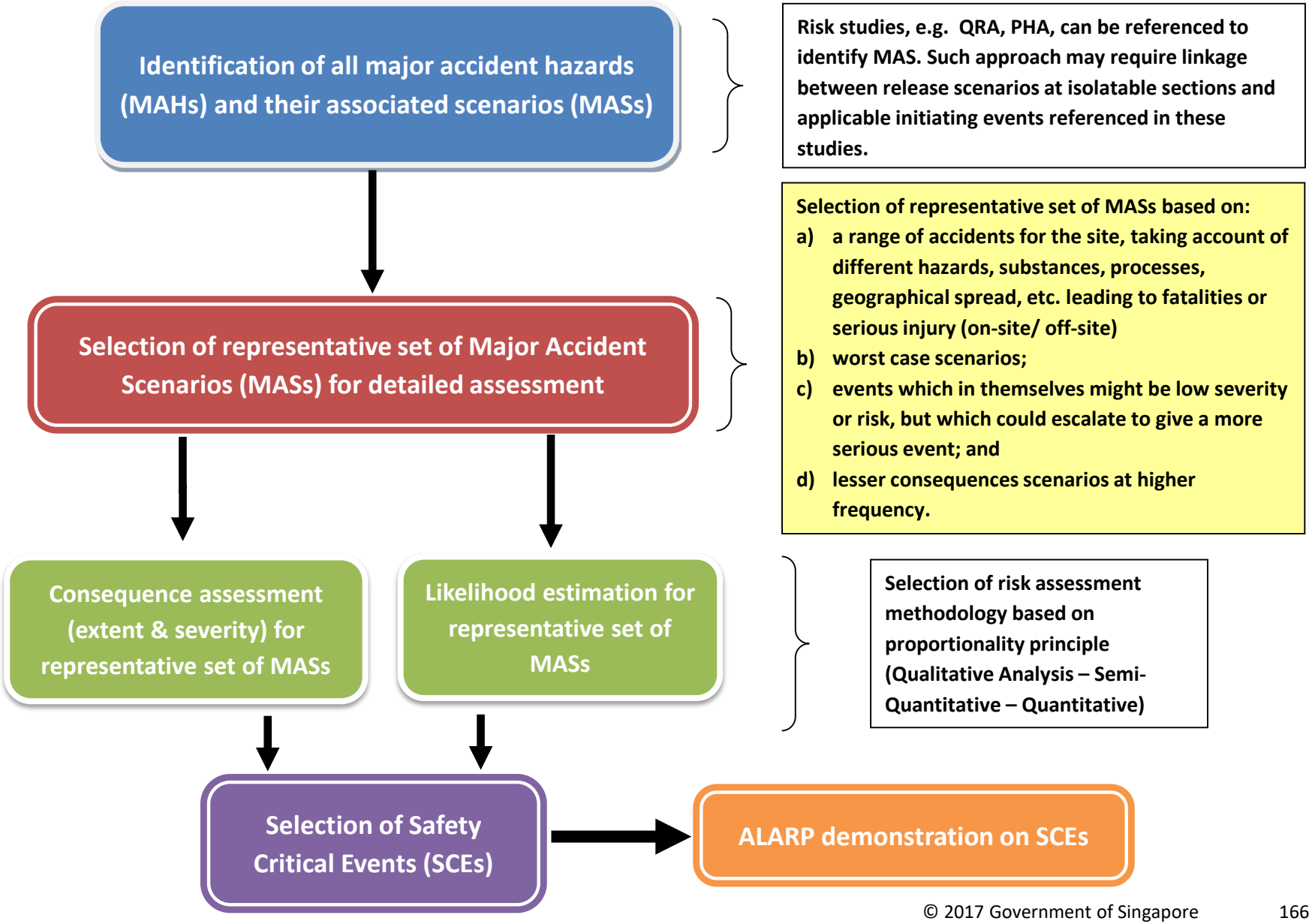
Closing Remarks



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Closing Remarks

Technical aspects

- MHIs to demonstrate that barriers in place are adequate, effective and reliable
- Barriers to follow hierarchy of control
- Ensure that barriers are independent
- Barriers for SCEs can also apply to other MASs
- Phased implementation approach by MHI for Human Factors

ALARP demonstration

- SCEs are for ALARP demonstration, that barriers continue to be adequate, effective and reliable
- Cost-Benefit Analysis (CBA) is a last resort
- Laying out options of independent barriers qualitatively is one of the preferred ways

- To facilitate preparation, make an appointment with MHD for Safety Case Clinics
- MHD will conduct on-site verifications on MHI's Safety Case

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Closing Remarks

A Safety Case is NOT…

- A mere description of the MHI
- Providing data about the MHI

A description is not a demonstration

A Safety Case is…

- A reasoned argument that risks of major accidents remain ALARP

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Thank You!