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Safety Case Compliance for Major Hazard Installations

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This paper will address functional safety and the link to the technical aspects of safety case submission under the new Ministry of Manpower's Major Hazards Installations Regulations. The paper will help process engineers, plant managers, electrical, instrumentation, controls engineers and MOM-approved consultants to understand the Regulations and identify gaps in their functional safety documentation so that timely action plans can be implemented before the safety case submission deadline.

Singapore's Ministry of Manpower has introduced a set of Major Hazards Installations (MHI) Regulations under the Workplace Safety and Health Act, to be implemented from the last quarter of 2017 through 2019. The core feature of the MHI Regulations is the Safety Case Regime where the submission of a safety case is compulsory.

A safety case is a structured argument produced by an MHI operator, which:

- Identifies the hazards and risks that may lead to a major accident
- Describes how the risks are controlled
- Describes the safety management system in place to ensure controls are applied in a consistent and effective manner; and
- Demonstrates that all major accident risks have are As Low As Reasonably Practicable (ALARP).

MHIs are permitted to engage external consultants with relevant experience to help in the preparation of safety case submission. However, responsibility for the safety case lies with the MHI themselves. The external consultants can also help to build in-house capability so as to maximise benefits from the safety case implementation and to support future reviews. The safety case documentation needs to be kept current.

MHIs are currently regulated by three governmental agencies. MOM regulates MHI workplace safety and health, the National Environment Agency (NEA) regulates MHI environmental impact and control of hazardous chemicals and the Singapore Civil Defence Force (SCDF) regulates the transport, storage and use of flammable substances and the relevant fire safety provisions, including emergency preparedness.

The MHI Regulations come under the purview of the new National MHI Regulatory Office (NMRO), Ministry of Manpower. For the industry, the NMRO will act as a single regulatory body for all Safety, Health and Environment matters in MHIs. The NMRO will have the authority for the oversight and intervention to safeguard the integrity and safety of MHIs.

What are MHIs?

MHIs are premises where there are processing, manufacturing or bulk storage of any of the government-controlled dangerous substances. Also, another additional condition for the classification as a MHI is that the quantity of these dangerous substances would be at a predetermined level.

In Singapore, MHIs comprise petroleum refining, petrochemical manufacturing facilities, chemical processing plants and installations where large quantities of toxic and flammable substances are stored or used. There are currently around 110 MHIs in Singapore.

The definition of a workplace as an MHI depends on:

- The nature of work activities
- The inventory levels of the dangerous substances (present, or likely to be present) meeting or exceeding threshold quantities.

Why the need for safety case?

While the likelihood of a major accident is low for MHIs, their complex operating environment and large quantities of highly hazardous chemicals means that any accident can result in catastrophic consequences.

The Safety Case Regime ensures that MHIs take on greater responsibility for the risks they create while at the same time, giving MHIs the flexibility to tailor their risk mitigating measures to best suit their needs. The Safety Case Regime is also used in Europe, UK and Australia for the management of MHIs.

The Safety Case Regime also demonstrates to the relevant authority that the MHIs have control measures in place to prevent major accidents or limit their consequences. To achieve this aim, MHIs must systematically examine their facility, and assess the potential for major accidents.

The safety case should list what systems and precautionary measures the MHIs have in place or are going to implement to prevent major accidents. A well-constructed safety case will demonstrate that MHIs have assessed their control measures and how organisational, technical and human factors contribute to safety in their installations. It also shows that MHIs have arrangements in place to rectify any shortcomings identified.

Therefore, through the preparation of the safety case, MHIs demonstrate how they meet the fundamental obligations under the Regulations for the prevention and limitation of major accidents.

Generally, safety case preparation should involve staff from different levels of the organization, including leadership, middle management, supervisory and ground staff.

Team members will include personnel who understand the plant design and operation; staff with expertise on Quantitative Risk Assessment and Process Hazard Analysis; engineers well versed in process safety, electrical and instrumentation, mechanical and human factor aspects; safety officers/managers; emergency response team members; and decision makers for ALARP demonstration.

Technical aspects: One of the key regulatory requirements for safety case

There are several key regulatory requirements when it comes to documentation for the safety case, one of which is the technical aspects. This section will focus on the technical aspects.

The technical aspects are concerned with the measures MHIs have put in place to prevent or mitigate against major accident hazards, and to limit their consequences to people and the environment.

The end goal is to demonstrate that the risk of major accident hazards have been reduced to a point where they are ALARP. In other words, the risks are at a level that is perceived as acceptable to workers and the general public.

There are five main elements, relating to the life cycle of the MHIs, to be considered when demonstrating how MHIs prevent major accidents or limit their consequences. The five are design, construction, operation, maintenance and modification or decommissioning.

For the technical aspects, there are four criteria that the authority will look out for during assessment of safety cases.

- **Process safety.** This domain aims to ensure that suitable process safety techniques are included in the design and operations. For example, were the hazard identification studies carried out adequate? Were inherent safety design principals considered before prevention and mitigation strategies?

- **Mechanical.** The mechanical engineering assessment looks for demonstration of adequate mechanical integrity, within the design and ongoing operations.

- **Human factors** require demonstration that measures have been taken to prevent foreseeable human errors.

- **Electrical Control and Instrumentation (EC&I).** One of the key goals of the EC&I assessment is to ensure the Safety Instrumented Systems protecting the MHI meet functional safety standards.

Within EC&I, functional safety is a priority item. If the MHI is relying on a Safety Instrumented System, then demonstrating the risks are ALARP will be impossible without demonstrating functional safety has been achieved.

Typical Safety Instrumented Systems protecting MHIs may include: Emergency Shutdown Systems; Burner Management Systems; Turbine Shutdown Systems; Fire and Gas Systems, High-Integrity Pressure Protection Systems.

What is functional safety?

Functional Safety is focused around ensuring Safety Instrumented Systems are available and ready to respond during a major accident event. Should the Safety Instrumented Systems fail to respond correctly during one of these events, it could lead to the realisation of catastrophic consequences.

In order to ensure these Safety Instrumented Systems are available and respond correctly, they need to be designed and maintained in a manner that minimises the potential for failure or error.

Functional Safety standards help to ensure consistent and robust processes are developed and followed throughout the systems lifecycle, from Concept – Analysis – Design – Implementation – Operation and Maintenance – Modification – Decommissioning. This ensures due consideration is given to minimise the risk of failures or errors, such as hardware failures, software failures, human errors, or environmental influences.

Following Functional Safety standards allows operators to design and maintain Safety Instrumented Systems that provide a desired level of risk reduction. As such, these systems typically form a critical aspect of any ALARP demonstration.

Therefore, when addressing the technical aspects of their safety case, MHIs are required to demonstrate functional safety has been adequately addressed for all relevant phases of the systems lifecycle.

The Ministry of Manpower has provided examples of functional safety documents MHIs could cite to provide this demonstration.

Examples include:

- Safety integrity level (SIL) assessment records
- Sample safety requirements specification
- Sample of Safety Instrumented Systems competency records
- Functional safety assessment
- Safety Instrumented Systems proof test
- Proof test records
- Safety Instrumented Systems management of change records

About the author

Jamie is the Principal Safety & Risk Engineer at HIMA Consulting. Jamie possesses experience in process and functional safety including HAZID/HAZOP, LOPA, SIL Assessment, SIL verification, functional safety management, and operations and maintenance across oil & gas and mining sectors. He can help MHIs to understand the role of functional safety within the technical aspects of the Safety Case Regime, through consulting and training.

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