Guidelines for management of safety critical elements (SCEs)

GUIDELINES FOR MANAGEMENT OF SAFETY CRITICAL ELEMENTS (SCEs)

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1 INTRODUCTION, SCOPE AND APPLICATION

1.1 INTRODUCTION

The process industries, including energy industry sectors such as oil and gas E&P, petroleum refining and bulk storage, and conventional (thermal) power generation cannot be absolutely safe. Organisations in those sectors manage the safety of their operations using risk management processes, which include having safety management systems with a proportionate focus on process safety so as to identify hazards and manage risks throughout the life cycle of a facility. Of particular concern are MAHs, which include events with safety-related consequences such as structural failure, fire, explosion, or loss of containment of a dangerous substance that cause, or have a significant potential to cause, death or serious personal injury to multiple persons. It should be noted that in some countries there is no established requirement for MAH management; also, where established, there are differences in what constitutes an MAH for different competent authorities around the world.

The purpose of this technical publication is to provide 'industry' guidance for the management of SCEs, focusing mainly on assurance and verification aspects. Following the guidance provided here should ensure that SCEs are identified, operated, inspected, tested and maintained in an appropriate way to the integrity of their operation and of the people that they protect.

An SCE is any part of a facility, plant, or computer program, the failure of which could cause, or contribute substantially to, an MAH; or the purpose of which is to prevent or limit the effect of a MAH. Examples of SCEs are ignition control/prevention and escape routes. Some SCEs are system based and may comprise a set of safety critical equipment or components; for example, a fire and gas (F&G) detection system SCE may comprise a set of individual gas or fire detectors (as sensor subsystems) and a logic solver subsystem (a.k.a. controller subsystem). This in turn may link to an emergency shutdown (ESD) system SCE.

For effective SCE management, a robust and appropriate process for MAH identification and risk assessment should be used. The process should include the use of a set of methodologies to identify MAHs, assess risks, and identify risk reduction measures to reduce risks, including defining appropriate SCEs. Whilst SCE selection is not the main focus of this technical publication, some guidance is provided on issues that should be considered in an MAH identification and risk assessment process.

Prior to selecting SCEs designers and operating companies should have implemented inherently safer design principles by adopting a hierarchy of measures (a.k.a. hierarchy of controls) that avoid MAHs instead of reducing risks from them.

EU Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on Safety of Offshore Oil and Gas Operations (a.k.a. OSD) promotes the wider term SECE, rather than SCE. This reflects the potential for MAHs to have environmental consequences (i.e., as major environmental incidents (MEIs)) as well as safety consequences. The focus of this technical publication is safety to people and therefore it purposely focuses on SCEs. Whilst the principles set out in this technical publication are written for SCE management, they also should be applicable to broader SECE management. It is likely that many SCEs also are SECEs.

Environment, reputation and asset protection aspects also may drive risk management. For environmental protection and mitigation, measures similar to SCEs are termed environmental critical elements (ECEs); for specific guidance see EI *Guidelines for the identification and management of environmentally critical elements*.

An overview of the SCE management process is shown in Figure 1. This is a high-level depiction of the key components that should be in place to manage SCEs, as explained throughout this technical publication.

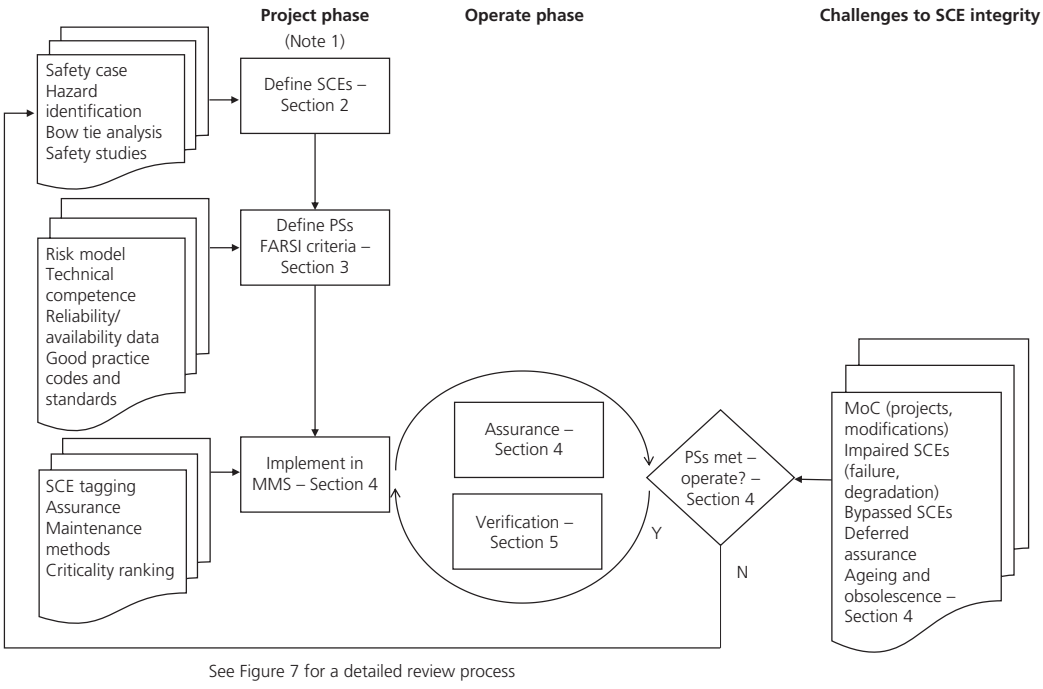

Figure 1: SCE management process

Notes:

1. Project phase comprises opportunity study, concept selection, define – front end engineering design (FEED), and design, construct and commission.

Human and organisational factors should not be considered as SCEs themselves; yet human and organisational factors can support or challenge SCEs (and risk reduction measures more generally). This may include leaders recognising the potential of their operations to cause MAHs and knowing the role of SCEs to prevent and mitigate them. More generally, human and organisational factors may range from putting in place and demonstrating the right process safety culture and learning from audits and reviews, through to ensuring success in front-line operator detection, decision making and taking action (e.g. correctly and promptly diagnosing the need to manually actuate an SCE), and avoiding human failure. Relevant human and organisational factors should be identified and managed, from concept selection in design through to decommissioning life cycle phases, in order to establish and sustain safe SCEs for MAH management.

Change is a challenge to managing SCEs and has the potential to increase risk during all phases of a process industry facility life cycle. There should be a robust MoC process in place.

1.2 DEVELOPMENT APPROACH AND KEY TECHNICAL CHANGES

The first edition of EI *Guidelines for management of safety critical elements* was developed by a United Kingdom Offshore Operators Association (UKOOA) led working group and

published in 1996. The purpose at that time was to produce 'industry' guidance for the transitional period for offshore oil and gas facilities designed and built under the former National Archives Offshore Installations (Construction and Survey) Regulations 1974, which required a 'certificate of fitness', but which then had to comply with the National Archives Offshore Installations (Safety Case) Regulations 1992. At this time, a new verification regime was introduced.

The 2nd edition was developed by an EI led working group and was published in 2007. This captured experience and learnings since 1996. To that time, the focus was primarily on offshore oil and gas E&P facilities in the United Kingdom (UK) Continental Shelf.

This 3rd edition has updated the 2nd edition so as to:

- Capture experience in SCE management.
- Make it applicable to oil and gas E&P sector facilities beyond UK Continental Shelf.
- Make it applicable to onshore (typically midstream and downstream) oil and gas process facilities, and conventional (thermal) power generation facilities, as the 2nd edition had been applied by some operating companies to facilities such as petroleum refineries.
- Take cognisance of globalisation and the increasing prevalence of legislation and competent authorities requiring a goal-setting approach to MAH management, and some specifically requiring verification; whilst recognising that in other countries the approach to MAH management is not mature or is not subject to legislative and competent authority requirements, such that the onus is on operating companies to self-regulate their operations.
- Set it in the context of the latest European Union (EU) (e.g. OSD), UK and Great Britain (GB) legislative and competent authority requirements. It also refers in Annex B to other international and national requirements, including legislation, regulations and technical publications (e.g. codes, standards and industry good practice).

In doing so, it provides:

- new guidance on SCE development and management in project phases, from initial SCE suitability through to ongoing SCE suitability;
- additional typical examples of MAHs;
- additional typical examples of SCEs;
- new guidance on the role of human and organisational factors in SCE management;
- new guidance on the role of change, which is a challenge to SCE management;
- additional guidance on developing performance standards (PSs);
- new guidance on using SIL determination to set and measure performance targets in PSs;
- additional guidance on assurance aspects of SCE management, to rectify an imbalance with the amount of guidance on verification in the 2nd edition;
- new guidance on implementation of SCE integrity assurance, such as its interface with maintenance management;
- new guidance on SCE management at system, equipment and component levels;
- new guidance on determining SCE criticality;
- new guidance on SCE performance, review and continual improvement, and
- new guidance on managing SCE ageing, obsolescence and life extension.

In addition, the 3rd edition provides practical examples to support the guidance.

The 3rd edition therefore provides a robust and updated 'industry' benchmark of good practice in managing SCEs for organisations operating in the high hazards industrial sectors. Adopting its guidance should enable industry operating companies to ensure initial and ongoing suitability of SCEs, and so contribute to improving their PSM capability.

1.3 SCOPE

The purpose of this technical publication is to provide guidance on how to manage SCEs throughout the life cycle of a facility from conceptual design through the operate phase to changes such as life extension and decommissioning. The focus is mainly on assurance and verification aspects of SCE management. Whilst SCE selection is not the main focus of this technical publication, some guidance is provided on issues that should be considered in an MAH identification and risk assessment process.

In terms of risk drivers, the focus of this technical publication is safety to people and therefore it purposely focuses on SCEs. Environment, reputation, business continuity and asset protection (e.g. insurance) risk drivers also may drive risk management. A similar approach to that set out herein for managing SCEs also could be adopted for other risk drivers. For specific guidance on ECE management see EI *Guidelines for the identification and management of environmentally critical elements*.

This technical publication provides guidance on the key steps in the SCE management process set out in Figure 1. Key areas covered are:

– selecting and implementing appropriate SCEs so as to manage the risk from MAHs;
– maintaining integrity of SCEs through inspection, maintenance and testing, and
– managing risk during operations if SCEs are unavailable or cannot operate as designed.

Whilst the focus of this technical publication is on SCEs, operating companies should also address operational MAH risk reduction measures, by using safety critical task analysis (SCTA) to ensure that they can be carried out correctly and in the available time. See EI *Guidance on human factors safety critical task analysis*. Safety critical tasks are not considered here.

1.4 APPLICATION

This technical publication is intended for use by process safety specialists, technical safety engineers, designers and asset management specialists working in engineering, procurement and construction (EPC) contractor companies, operating companies (or duty holders under legislation or regulations), verification bodies and competent authorities. It should be of particular use to those involved with SCE assurance and verification, including those organisations that provide asset management (inspection, maintenance, testing and repair) and verification services to operating companies. The intended applications are process industry sector facilities where there are MAHs; these may be new or existing facilities. It promotes SCE management throughout the life cycle of a facility from conceptual design through the operate phase to changes such as life extension and decommissioning.