Guidelines for management of safety critical elements (SCEs)

energy institute

GUIDELINES FOR MANAGEMENT OF SAFETY CRITICAL ELEMENTS (SCEs)

Third edition

January 2020

Published by
Energy Institute, London
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Registered charity number 1097899

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This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

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The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies:

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Uniper
Valero
Vattenfall
Vitol Energy
Woodside
World Fuel Services

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ISBN 978 1 78725 155 7

Published by the Energy Institute

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FOREWORD

The process industries, including energy industry sectors such as oil and gas exploration and production (E&P), petroleum refining and bulk storage, and conventional (thermal) power generation, 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 major accident hazards (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.

The purpose of this technical publication is to provide 'industry' guidance for the management of safety critical elements (SCEs). 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 an MAH.

The scope focuses mainly on assurance and verification aspects of SCE management.

Whilst the principles set out in this technical publication are written for SCE management where the potential impacts are to safety, the principles also should be applicable to broader safety and environmental critical element (SECE) management.

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

- Capture experience in SCE management.
- Make it applicable to a wider range of facilities.
- Recognise the range of maturity of international legislation and competent authority requirements for SCE management, which include some that mandate verification through to those with little specific requirement for MAH management.

In doing so, it provides:

- new guidance on SCE development and management in project phases, from initial SCE suitability through to ongoing SCE suitability;
- 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 safety integrity level (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 process safety management (PSM) capability.

The information contained in this publication is provided as guidance only. Whilst every reasonable care has been taken to ensure the accuracy of its contents, neither the Energy Institute (EI), nor the representatives listed in the Acknowledgements, can accept any responsibility for any actions taken, or not taken, on the basis of this information. The EI shall not be liable to any person for any loss or damage that may arise from the use of the information contained in any of its publications.

The intent is to review and where necessary update this technical publication periodically. Comments or suggestions for improvement (e.g. relevant project experience) should be sent to:

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ACKNOWLEDGEMENTS

The 3rd edition of EI *Guidelines for management of safety critical elements (SCEs)* was commissioned by the EI's Process Safety Committee (PSC) and authored under the direction of a collaborative Working Group by David McLean and colleagues (Lloyd's Register). Working Group members during the project comprised:

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Chris Bradley	BP
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Toby St. Leger (later Chairperson)	ConocoPhillips
Dr Mark Scanlon	Energy Institute
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Paul Irvine	Nexen CNOOC
Dr Keith Lewis (R.I.P.)	Total

EI acknowledges their direction and technical contributions to the project, which includes providing experience and documentation.

EI also acknowledges the following reviewers who provided significant comments during the stakeholder technical reviews that facilitated content consensus building:

Peter Gedge	BP
Dr John Morgan	DNV-GL
Ahmed Omar	Eni Engineering
Dr Andy Rushton	ESR Technology
Dave Mansfield	ESR Technology
John Briggs	Kuwait Petroleum International
Dr David Piper	Total

Several of those reviewers were members of the Oil and Gas UK (O&GUK) Major Hazards Work Group or the International Association of Oil and Gas Producers (IOGP) Process Safety Sub-Committee.

The listings refer to representatives' last affiliation whilst participating.

LR is acknowledged for providing some research funding to co-fund the technical development project to revise this technical publication.

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Dr Mark Scanlon (EI) managed the technical development project and technically edited this technical publication.

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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*.