Corrosion threats handbook
Upstream oil and gas production plant
Acknowledgements

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The origins of this document and further details of the Work Group can be found in the associated publication: *Guidance for corrosion management in oil and gas production and processing* which is referenced throughout this document.

Foreword

This publication was compiled to enhance the awareness of corrosion for a large cross section of personnel within the oil and gas industry. It was produced in parallel to the main guideline publication, *Guidance for corrosion management in oil and gas production and processing* which was prepared following consultation with a large cross section of UK offshore operators, specialist contractors and independent verification bodies who have a role in the control of corrosion.

This document is for guidance only, and while every reasonable care has been taken to ensure the accuracy and relevance of its contents, the Energy Institute, its sponsoring companies, the document writer and the Working Group members, shall not be liable to any person for any loss or damage which may arise from the use of any of the information contained in any of its publications.

This handbook may be reviewed from time to time and it would be of considerable assistance for any future revision if users would send comments or suggestions for improvements to:

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Introduction

Oil and gas production facilities must continue to strive for, and improve, safety, environmental, production and cost goals at a time when many UK plants are extending their period of operation beyond their original design life. Effective management of corrosion of the structures and systems is a core requirement to achieve those goals. The role of plant operation, maintenance, inspection and support personnel is, in turn, critical in maintaining the integrity of their plant. The Energy Institute has commissioned this guide as a concise reference tool to assist these individuals by providing practical information to illustrate the corrosion degradation mechanisms likely to affect upstream oil and gas production systems, structures and components. The guide outlines the causes of the corrosion threats, shows typical locations for their occurrence and gives examples of how the threats may be managed.

The guide is intended for use by plant engineers and personnel with direct and indirect responsibility for the long-term integrity of production facilities. It should assist system housekeeping and more formal integrity audits. The guide should also be of value to practitioners of Integrity Management, especially those less familiar with corrosion issues specific to oil and gas production plant.

The information should allow the user to:

- Understand the key corrosion threats (both internal and external corrosion)
- Understand the typical appearance of the main threats
- Understand where the threats may occur
- Identify the conditions which may give rise to threat
- Consider actions to mitigate the threat

The majority of the corrosion threats apply to carbon steel, the most commonly used material for upstream oil and gas production systems, structures and components. Threats to other materials are identified.

This guide has been prepared to supplement the Energy Institute publication *Guidance for corrosion management in oil and gas production and processing*. Where appropriate, reference has been made to the relevant sections of Appendix B of that document, where more detailed information on managing each of the corrosion threats can be found.

The information in this guide should NOT be used to the exclusion of established and applicable codes, standards and criteria; nor should the threats and their manifestation described in this guide be seen as exhaustive. Please notify and consult with the relevant technical engineering authority/discipline specialists for investigation of potential threats or actual degradation that may be observed.

The corrosion threats in this guide are presented either as specific corrosion mechanisms, e.g. microbial corrosion, erosion corrosion; or by location, e.g. external corrosion, corrosion under insulation. In addition to the threats which are strictly corrosion, three other degradation processes are included in this handbook. They are: erosion, fatigue and fretting. In practice, corrosion may be driven by two or more mechanisms. Typically, the resultant corrosion rate is faster than would be anticipated from a single mechanism.
Corrosion basics

The metal used to fabricate process plant and structures is a metastable material. Fundamental laws of thermodynamics tell us that metals we use have the innate potential to convert to a more stable (lower energy) form.

The rusting of steel is a well known example of the conversion of a metal (iron) into a more stable, lower energy state, non-metallic product (rust). The change in energy of the system is the driving force for this process. It is no coincidence that the corrosion products we observe on our facilities are the same compounds as the original ores from which the metals were extracted, for example, iron oxides, iron carbonates and iron sulphides.

Controlling corrosion

It follows therefore that, without our intervention, the metals from which facilities are fabricated will inevitably return to the non-metallic compounds from which they were extracted.

Recognising the indicators of degradation and understanding the causes, forms the basis of the process by which the threat of corrosion may be managed.

The fire triangle analogy

The majority of the corrosion reactions which occur in upstream production facilities are aqueous oxidation processes. As such they are analogous to combustion, another process by which a material is oxidised (by the oxygen in air) to a lower energy compound. The well known Fire Triangle has an aqueous corrosion equivalent, which may aid our understanding of corrosion and the methods used to mitigate corrosion.