

# Guidelines on sand erosion and erosion-corrosion management

# GUIDELINES ON SAND EROSION AND EROSION-CORROSION MANAGEMENT

First edition

June 2017

Published by

**Energy Institute, London**

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

Apache North Sea	Repsol Sinopec
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ISBN 978 0 85293 998 7

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## FOREWORD

This is the first edition of the Energy Institute (EI) *Guidelines on sand erosion and erosion-corrosion management*. Development of these guidelines was initiated in 2015 in response to ongoing erosion and erosion-corrosion issues causing pipework leakages and interruptions to oil and gas production.

This publication provides an overview of 'through life management' of sand erosion and erosion-corrosion in oil and gas production pipework and downhole completions between the reservoir and the export meter.

This publication has been compiled for guidance only and is intended to provide knowledge of good practice to assist operators develop their own management systems. While every reasonable care has been taken to ensure the accuracy and relevance of its contents, the EI, its sponsoring companies and other companies who have contributed to its preparation, cannot accept any responsibility for any action taken, or not taken, on the basis of this information. The EI 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.

These guidelines 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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## ACKNOWLEDGEMENTS

The EI wishes to record its appreciation of the work carried out by the following individuals over the project duration:

Steering group members:

Louise Mearns (Initial Chair)	Apache
Dave Hillis (Closing Chair)	Total
Richard Carroll	BG Group
Alistair Crichton	Marathon
Jack Fraser	BP
Phil Ligertwood	Chevron
John MacDonald	Chevron
Ali Moncur	SMS
Caroline Scott	Shell
Geraint Rhys-Davies	TAQA Bratani
Konstantinos Vatopoulos	Saudi Aramco

Technical drafting: Neil Barton, Xodus Group

Editing: Jim McGhee, Xodus Group

This first edition guidance was coordinated and managed by Dr Cameron Stewart, EI, Upstream Technical Manager.

Additional assistance was kindly provided by:

Larry Bohaychuk	Masterflo
Colin Jones	Chevron
Ardjan Kopliku	BP
Brenton McLaury	University of Tulsa
Kjetil Nysæter	ClampOn
Steinar Orre	Statoil
Hank Rawlins	eProcess Technologies
Siamack Shirazi	University of Tulsa
Dirk Van Oostendorp	Xodus Group
Eirik Walle	ClampOn

## SUMMARY

This publication provides guidance to help minimise the risk of sand erosion and erosion-corrosion in oil and gas production piping. It is intended for use by engineers with no prerequisite knowledge of erosion or erosion-corrosion.

Pipework erosion and erosion-corrosion is only superficially covered by standard design codes, and hence awareness of the problem among plant designers and operators is limited (e.g. API RP 14E *Recommended practice for design and installation of offshore production platform piping systems*). It is intended that this publication will address this issue.

These guidelines provide an overview of various approaches to the management of erosion and erosion-corrosion, defined as internal damage to pipework components caused by sand or similar particles. Basic damage mechanisms are described followed by a brief overview of sand management, erosion assessment methods and system design to avoid erosion problems. This publication is not intended to provide comprehensive guidance on the larger subject of sand management, but additional material is provided on this subject for background information.

Erosion and erosion-corrosion management is a complex subject and it is recognised that some potential problems may not be covered in this publication. In such cases specialist advice should be sought.

# 1 INTRODUCTION

## 1.1 SCOPE AND DEFINITIONS

In oil and gas production pipework erosion occurs when particulates in the produced flow stream impact on pipe walls and remove material. This publication provides guidance on the avoidance and management of erosion and erosion-corrosion in oil and gas production systems.

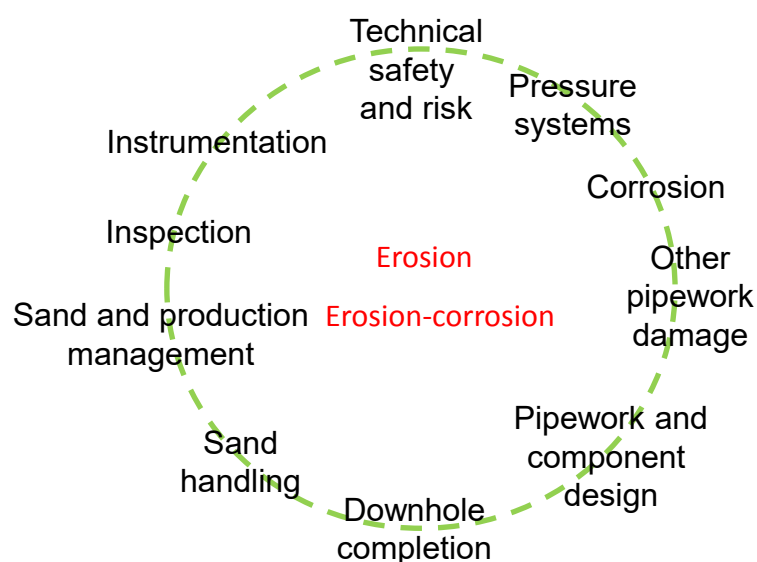
The scope covers:

- Damage to internal pipe and component surfaces caused by particle impacts.
- All tubing and pipework from reservoir to the export meter, including the sand screens and well completion, production pipework, produced water, water injection, sand handling and drilling facilities.

Erosion and erosion-corrosion management requires input from a wide range of disciplines and there is considerable overlap with related technical areas, as shown in Figure 1. Summary information is given on wider subjects as required.

Internal pipework damage can be caused by a number of processes other than erosion and erosion-corrosion. These processes are beyond the scope of this publication, but they are briefly discussed in Annex A:

- corrosion;
- cavitation damage;
- droplet erosion;
- erosion then corrosion e.g. failure of an Inconel lining;
- corrosion in pipework under sand deposits, and
- sand abrasion.



**Figure 1: Scope of this guideline**

### 1.1.1 Definition of erosion

Particle erosion occurs when a particle impacts on a surface, removing a small amount of material. After a large number of impacts the total surface loss can be enough to cause a functional failure, for example a pipe wall penetration and leak.

Details of the erosion mechanism depend on the impact severity and properties of the particle and the surface material (see Figure 2). In materials, erosion takes place as material is removed by a cutting action (sometimes termed micro-machining). In brittle materials, cracks are generated by numerous impacts. These cracks join together allowing flakes of material to be removed.

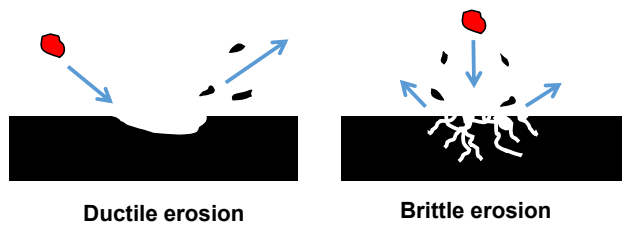


Figure 2: Illustration of the erosion process

### 1.1.2 Definition of erosion-corrosion

Erosion-corrosion is caused by an interaction of the erosion and corrosion processes. When corrosive fluid flows through a pipe at low velocity a corrosion layer will develop on the wetted surface. The corrosion rate reduces as this protective layer forms a barrier between the base material and the fluid and eventually corrosion will slow or stop. In particle-laden flow impacts can remove the protective layer, thus accelerating the corrosion process. This typically results in pitted surface damage as shown in Figure 3.

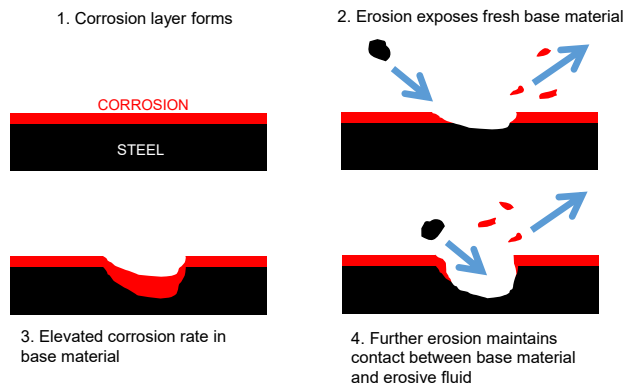


Figure 3: Illustration of the erosion-corrosion process

There is some variation in the precise definition of erosion-corrosion. In this publication the term erosion-corrosion refers to damage on corroded surfaces caused by particles (also known as solid erosion-corrosion).

Fast-flowing, particle-free liquid flows can also strip protective layers and accelerate corrosion in a process known as liquid erosion-corrosion. Liquid-erosion corrosion is outside the scope of this publication.

## 1.2 MOTIVATION

Erosion and erosion-corrosion are complex phenomena which can result in sudden, unexpected failures, with major safety and financial consequences. They also significantly, and often unnecessarily, limit production rates. For example, McGillivray and Hare, *Offshore hydrocarbon releases 2001–2008* stated that 14 % of topsides leaks in the UKCS between 2001 and 2008 were attributed to erosion and sand was found to have limited production in 80 % of the wells for one large operator in 2007, see T. Knudsvik, *Sand management in Statoil*.

This publication aims to assist in the implementation of better erosion management strategies, ultimately permitting higher production rates whilst improving safety.

## 1.3 HOW TO USE THIS PUBLICATION

The contents of this guide are summarised in Figure 4. Summaries are included in the main text with more detailed discussion in a series of Annexes.

These guidelines provide an overview of the subject of erosion and erosion-corrosion management. They provide advice, but are not intended to be prescriptive.

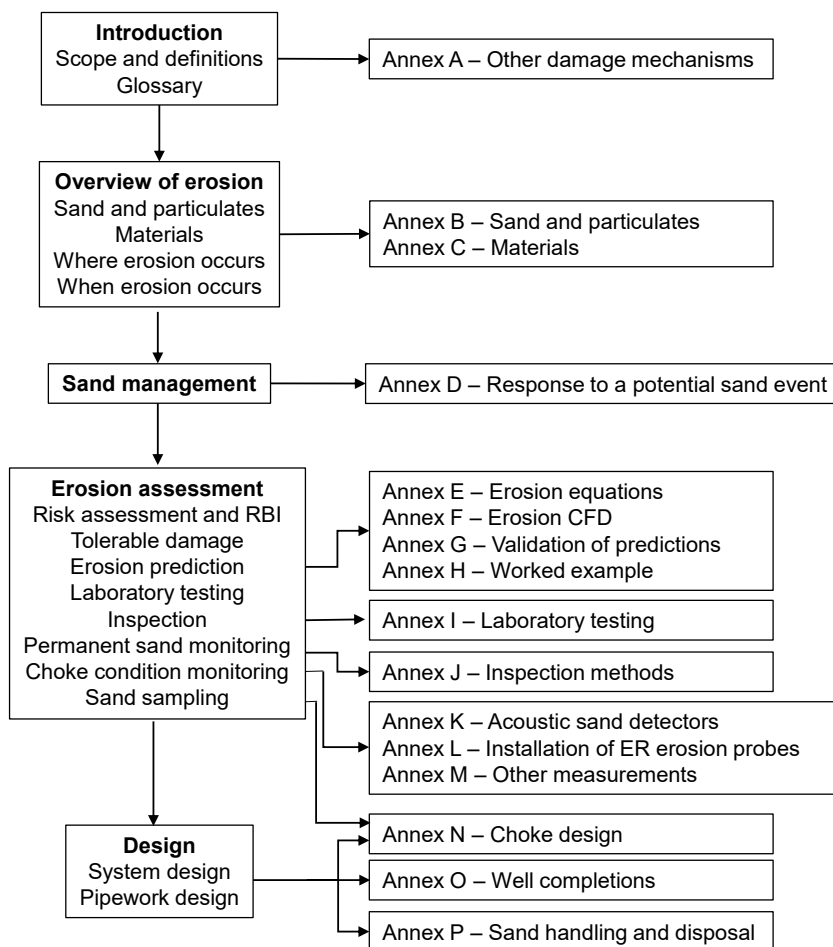


Figure 4: Guidelines overview