

El Research report

Measures and key performance indicators
to manage maintenance in upstream
petroleum production

RESEARCH REPORT: MEASURES AND KEY PERFORMANCE INDICATORS TO
MANAGE MAINTENANCE IN UPSTREAM PETROLEUM PRODUCTION

First edition

January 2020

Published by
Energy Institute, London

The Energy Institute is a professional membership body incorporated by Royal Charter 2003
Registered charity number 1097899

The Energy Institute (EI) is the chartered professional membership body for the energy industry, supporting over 20 000 individuals working in or studying energy and 200 energy companies worldwide. The EI provides learning and networking opportunities to support professional development, as well as professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

The EI's purpose is to develop and disseminate knowledge, skills and good practice towards a safe, secure and sustainable energy system. In fulfilling this mission, the EI addresses the depth and breadth of the energy sector, from fuels and fuels distribution to health and safety, sustainability and the environment. It also informs policy by providing a platform for debate and scientifically-sound information on energy issues.

The EI is licensed by:

- the Engineering Council to award Chartered, Incorporated and Engineering Technician status, and
- the Society for the Environment to award Chartered Environmentalist status.

It also offers its own Chartered Energy Engineer, Chartered Petroleum Engineer, and Chartered Energy Manager titles.

A registered charity, the EI serves society with independence, professionalism and a wealth of expertise in all energy matters.

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.

For further information, please visit <http://www.energyinst.org>

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

BP Exploration Operating Co Ltd	Qatar Petroleum
BP Oil UK Ltd	Repsol Sinopec
Centrica	RWE npower
Chevron North Sea Ltd	Saudi Aramco
Chevron Products Company	Scottish Power
Chrysaor	SGS
CLH	Shell UK Oil Products Limited
ConocoPhillips Ltd	Shell U.K. Exploration and Production Ltd
DCC Energy	SSE
EDF Energy	TAQA Bratani
ENI	Total E&P UK Limited
E. ON UK	Total UK Limited
Equinor	Tullow Oil
ExxonMobil International Ltd	Uniper
Innogy	Valero
Kuwait Petroleum International Ltd	Vattenfall
Nexen CNOOC	Vitol Energy
Ørsted	Woodside
Perenco	World Fuel Services
Phillips 66	

However, it should be noted that the above organisations have not all been directly involved in the development of this publication, nor do they necessarily endorse its content.

Copyright © 2019 by the Energy Institute, London.

The Energy Institute is a professional membership body incorporated by Royal Charter 2003.

Registered charity number 1097899, England

All rights reserved

No part of this book may be reproduced by any means, or transmitted or translated into a machine language without the written permission of the publisher.

ISBN 978 1 78725 164 9

Published by the Energy Institute

The information contained in this publication is provided for general information purposes only. Whilst the Energy Institute and the contributors have applied reasonable care in developing this publication, no representations or warranties, express or implied, are made by the Energy Institute or any of the contributors concerning the applicability, suitability, accuracy or completeness of the information contained herein and the Energy Institute and the contributors accept no responsibility whatsoever for the use of this information. Neither the Energy Institute nor any of the contributors shall be liable in any way for any liability, loss, cost or damage incurred as a result of the receipt or use of the information contained herein.

Hard copy and electronic access to EI and IP publications is available via our website, <https://publishing.energyinst.org>.

Documents can be purchased online as downloadable pdfs or on an annual subscription for single users and companies.

For more information, contact the EI Publications Team.

e: pubs@energyinst.org

CONTENTS

	Page
Preface	6
Executive summary	7
Acknowledgements	8
1 Introduction	9
1.1 Introduction	9
1.2 Scope	9
1.3 Objectives	9
1.4 Application	10
2 Working group	11
2.1 Project purpose and objectives	11
2.2 Project brief	11
2.3 Interview questionnaire	11
2.4 Proposed participants	12
2.5 Documentation review	12
3 Interviews	13
3.1 Identification of contributors	13
3.2 Interview process	13
3.3 Operating company interview outputs	14
3.3.1 Value of performance measures	14
3.3.2 Selection of performance measures	15
3.3.3 Performance indicator coverage	15
3.3.4 Calculation	16
3.3.5 Presentation	16
3.3.6 Quality control	16
3.3.7 Evaluation of performance indicators	17
3.3.8 Evaluation of cumulative risk	17
3.3.9 Common definitions	17
3.3.10 Innovation	17
3.4 Regulator interviews	18
3.4.1 Health and Safety Executive (HSE)	19
3.4.2 Petroleum Safety Authority (PSA)	19
3.5 Review workshop	19
3.6 Categorisation and selection of performance indicators	20
3.7 Suggested performance indicators	21
3.8 Definition of performance indicators	22
3.9 Data collection and calculation	22
3.10 Testing, validation and quality control	23
3.11 Validity of performance measures	23
3.12 Analysis and presentation	24
3.12.1 Presenting overall performance and risk	24
3.13 Continued suitability of performance measures	25
3.14 Additional workshop findings	25

Contents continued

	Page
4 Documentation review	27
4.1 Regulations	27
4.2 Standards	27
4.2.1 BS EN ISO 20815:2018 <i>Petroleum, petrochemical and natural gas industries – Production assurance and reliability management</i>	27
4.2.2 BS EN ISO 14224:2016 <i>Petroleum, petrochemical and natural gas industries – collection and exchange of reliability and maintenance data for equipment</i>	28
4.2.3 BS EN 17007:2017 <i>Maintenance processes and associated indicators</i>	29
4.2.4 BS EN 15341:2007 <i>Maintenance – maintenance key performance indicators</i>	30
4.2.5 BS EN 13306:2017 <i>Maintenance – maintenance terminology</i>	31
4.3 Reports and guidelines	31
4.3.1 <i>Root causes of hydrocarbon leaks on offshore petroleum installations (Vinnem and Roed)</i>	31
4.3.2 <i>HSG 254 – Developing process safety indicators. A step by step guide for chemical and major hazard industries</i>	31
4.3.3 <i>IOGP Report 456 Process safety – recommended practice on key performance indicators</i>	32
4.3.4 <i>PD CEN ISO/TR 12489:2016 Petroleum, petrochemical and natural gas industries – reliability modelling and calculation of safety systems</i>	32
4.3.5 <i>RR1075 Benefits of data management and data trending in the UKCS oil and gas industry</i>	32
5 Standard definitions for maintenance performance indicators	33
5.1 Maintenance and inspection backlog	33
5.1.1 Definition of backlog	33
5.1.2 Measuring amount of overdue work	33
5.1.3 Definition of overdue maintenance	34
5.1.4 Definition of safety (and environmental) critical maintenance	34
5.1.5 Industry reporting	35
5.1.6 Risk associated with overdue work	35
5.2 Safety (and environmental) critical element (SCE/SECE) pre-planned maintenance (PPM) compliance	35
5.3 PM Deferral compliance	35
5.4 Preventive maintenance:corrective maintenance (PM:CM) ratio	36
5.4.1 Definitions	36
5.4.2 Effectiveness of PM:CM ratio	37
5.5 Maintenance and inspection schedule attainment	37
5.6 Mean [Elapsed] time between failure (M[E]TBF) per equipment type	37
5.7 Availability and reliability	38
6 Conclusions	39
6.1 Original work scope	39
6.2 Original objectives	40
6.3 Revised purpose and objectives	40
7 Recommendations	41

Contents continued

	Page
Annexes	
Annex A	Glossary of acronyms 42
Annex B	References and bibliography 43
Annex C	Project brief. 45
Annex D	Operator interview summary 47

LIST OF FIGURES AND TABLES

	Page
Figure	
Figure 1	Maintenance KPI coverage. 15
Tables	
Table 1	Maintenance performance indicator categories 20
Table 2	Suggested maintenance performance indicators by goal 21

PREFACE

The work contained in this research has been developed and supported by a working group with oversight provided by the Energy Institute (EI) Process Safety Committee. The intention of the research was to identify the state of practice with respect to maintenance management measures and key performance indicators. It is worthwhile to state that the working group did not universally subscribe to the recommendations of the report as described in Section 7, but all believed that there is genuine value to these being included in their entirety in the published report.

ACKNOWLEDGEMENTS

This technical publication was commissioned by the EI's Process Safety Committee (PSC) and developed by Mike Judd (Petrofac) with contributions from:

Richard Adams	Petrofac
Lee Allford	EI
Stuart Barnes	Conoco Phillips
Allison Bennett	TAQA
Matthew Blackburn	HSE
Roy Boag	HSE
Lee Broadley	Repsol Sinopec Resources UK
Kevin Bruce	TAQA
Jason Davidson	Repsol Sinopec Resources UK
Sam Daoudi	formerly EI
Andy Duncan	Intertek
David Holland	TAQA
Eivind Jåsund	PSA
Colin Martin	HSE
Mark McKenzie	National Grid
Stuart McIntosh	TAQA
Ole Jørgen Melleby	PSA
Carlos Montero	Repsol Sinopec Resources UK
Mark Nicholls	National Grid
Nils Martin Rugsveen	Equinor (formerly Statoil)
Mark Scanlon	EI
Don Smith	ENI
Graham Vincent	Petrofac
Daniel Wilson	Petrofac
Steven Young	Sharjah National Oil Corporation

The EI also wishes to record its appreciation of the valuable contributions of the following organisations that took part in interviews as part of this research project:

Conoco Phillips
ENI
Health and Safety Executive (HSE)
National Grid
Petrofac
Petroleum Safety Authority (PSA) – Norway
Repsol Sinopec Resources UK
Sharjah National Oil Corporation (SNOC) – Sharjah, United Arab Emirates
Equinor (formerly Statoil) – Norway
TAQA

1 INTRODUCTION

1.1 INTRODUCTION

This research report details the findings and recommendations of a research project into maintenance performance measures for the upstream oil and gas industry conducted on behalf of the EI.

1.2 SCOPE

The original scope of work provided by the EI was '*to research measures and key performance indicators to manage maintenance in order to develop guidelines on the practicalities of reporting maintenance management measures and KPIs*'.

The following tasks were to be undertaken:

- Review of ISO 20815:2008 and ISO 14224:2016 in the context of OSCR and PFEER.
- Review of additional standards, guidelines and reports as listed in Annex B. (Note: this list was expanded from the original requirement).
- Establish by bilateral engagement, current operational practices within the upstream petroleum sector, including how they use the findings of the outputs of verification assessments and how they use data to demonstrate SECEs (Safety and Environment Critical Elements) meet their performance standards (e.g. for availability and reliability).
- Establish by bilateral engagement, sector based reporting requirements.

The industry scope was upstream petroleum from subsea through to production/export, as per the intent of ISO 20815. ISO 14224 has a broader industry scope, but includes those upstream petroleum sectors.

Note: due note has been taken in this report of the update to BS EN ISO 20815:2018.

1.3 OBJECTIVES

The primary objective of this project was to develop guidelines on the practicalities of reporting maintenance management measures and KPIs covering:

- their definitions;
- what should be in/out of scope, and
- suitable times to run reports.

In particular, the project was to investigate the following typical KPIs:

- maintenance and inspection backlog;
- safety critical element (SCE) pre-planned maintenance (PPM) compliance (updated to SECE PPM compliance to align with latest versions of UK legislation);
- PM deferral compliance;