

DEP SPECIFICATION

METOCEAN DESIGN AND OPERATING CONSIDERATIONS FOR OFFSHORE AND ONSHORE STRUCTURES – ADAPTION TO CLIMATE CHANGE

DEP 37.00.10.14-Gen.

February 2015

DESIGN AND ENGINEERING PRACTICE



© 2015 Shell Group of companies

All rights reserved. No part of this document may be reproduced, stored in a retrieval system, published or transmitted, in any form or by any means, without the prior written permission of the copyright owner or Shell Global Solutions International BV.

This document has been supplied under license by Shell to:
UOP Honeywell ted.fuger@honeywell.com 20/04/2018 04:49:14

AVA Documents
Document Sharing Hub

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

The right to obtain and to use DEPs is restricted, and is typically granted by Shell GSI (and in some cases by other Shell Companies) under a Service Agreement or a License Agreement. This right is granted primarily to Shell companies and other companies receiving technical advice and services from Shell GSI or another Shell Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating Units having a Service Agreement with Shell GSI or another Shell Company. The use of DEPs by these Operating Units is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorised to use DEPs subject to appropriate contractual arrangements (whether as part of a Service Agreement or otherwise).
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, Shell GSI disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof, even if it is wholly or partly caused by negligence on the part of Shell GSI or other Shell Company. The benefit of this disclaimer shall inure in all respects to Shell GSI and/or any Shell Company, or companies affiliated to these companies, that may issue DEPs or advise or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of Shell GSI, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of Shell GSI. The copyright of DEPs vests in Shell Group of companies. Users shall arrange for DEPs to be held in safe custody and Shell GSI may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in Shell GSI.

TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	7
1.5	SUMMARY OF MAIN CHANGES.....	7
1.6	COMMENTS ON THIS DEP	7
1.7	DUAL UNITS.....	7
1.8	NON NORMATIVE TEXT (COMMENTARY).....	7
1.9	CLIMATE CHANGE RISK.....	7
2.	OVERVIEW.....	8
2.1	BACKGROUND	8
2.2	PORTFOLIO OVERVIEW.....	9
2.3	STANDARDS	9
2.4	CLIMATE CHANGE SCIENCE	10
3.	GENERIC ASSESSMENT OF RISK	10
3.1	MINIMUM REQUIREMENTS.....	10
3.2	CLIMATE CHANGE HAZARDS.....	10
3.3	GENERIC ASSESSMENT OF RISK	12
3.4	EXPOSURE, VULNERABILITY AND CAPACITY TO ADAPT	12
3.5	OFFSHORE FIXED PLATFORM AND TENSION LEG PLATFORM (TLP).....	13
3.6	OFFSHORE FLOATING PLATFORM (FPSO / FLNG / SEMI SUBMERSIBLE).....	14
3.7	OFFSHORE PIPELINE INCLUDING COASTAL APPROACH AND LANDFALL.....	15
3.8	COASTAL LNG PLANT/REFINERY/CHEMICAL PLANT/OTHER FACILITIES INCLUDING JETTY	16
3.9	ONSHORE LNG PLANT / REFINERY / CHEMICAL PLANT / OTHER FACILITY	17
3.10	ONSHORE PIPELINES OR BASIC ONSHORE FACILITY.....	18
3.11	OFFSHORE, COASTAL AND ONSHORE ARCTIC INFRASTRUCTURE	19
3.12	SUMMARY.....	21
4.	ASSESSMENT OF THE CLIMATE CHANGE HAZARD SEVERITY	22
4.1	GENERAL	22
4.2	STEP 1 – POTENTIAL ASSET RISK ASSESSMENT	22
4.3	STEP 2 – DATA DURATION FOR CLIMATE CHANGE ASSESSMENT.....	22
4.4	STEP 3 – CLIMATE MODEL DATA	22
4.5	STEP 4 – CLIMATE MODEL VALIDATION.....	23
4.6	STEP 5 – MODIFICATION OF DESIGN CRITERIA FOR CLIMATE CHANGE.....	23
4.7	STEP 6 – FACILITY LIFE TIME.....	24
4.8	STEP 7 – COMBINATION WITH OTHER PARAMETERS	24
5.	REFERENCES	25

1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for inclusion of climate change risk in metocean design criteria. It applies to offshore, coastal and onshore facilities where there is a need to include adaptation measures for climate change risk during the project design phase.

This DEP should be used in conjunction with DEP 37.00.10.10-Gen.

This DEP is primarily intended to ensure that new facilities and structures (both onshore, coastal and offshore), include appropriate 'anticipatory' design adaptation for climate change during the SELECT and DEFINE phases of the ORS such that expensive 'reactive' adaptations are not required during Operate phase.

Hence this DEP only requires climate change to be considered when the following criteria are met:

- The facility would be exposed to the climate change hazard
- The facility is vulnerable to the climate change hazard
- The capability of the asset to adapt to the hazard during the operate phase would be low and adaption expensive
- The robustness of the climate change science is high for the particular parameters and region
- There is a climate change hazard indicated by the climate change science

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
Adaption Adaptation	Process used to lower the risk associated with the consequences of climate change by adjustment to actual or expected climate and its effects. For assets, adaptation seeks to moderate or avoid harm or damage as well as exploit beneficial opportunities.
Climate change	Change in the state of the climate that can be identified by changes in the mean, extremes and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing and persistent anthropogenic changes in the composition of the atmosphere or in land use.
Capacity to adapt	If an asset can be adapted as easily and cost effectively during the Operate phase as in the Design phase, it has a high capacity to adapt. When capacity to adapt is low and risk is high, design adaptation is required. Capacity to adapt is linked to the ratio of Cost to adapt in Design / Cost to adapt in Operate.
Coastal	A location where the asset is near shore or onshore but sufficiently close to the coast or low lying to be influenced by coastal processes including extreme events.
Exposure	Presence of facilities, people, ecosystems, environmental resources, services, resources and infrastructure in places and settings that could be adversely affected by the hazard
Hazard	Potential of occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.
Hazard severity	Change in the hazard parameter for the future period of interest compared to the reference period. It can be defined as a percentage change or in the unit of the hazard parameter at the required probability of exceedence.
Impacts	Effects on natural and human systems. In this DEP, the term impacts is used primarily to refer to the effect on assets of extreme weather and climate events and of climate change, but can also be consequences and outcomes.
Design adaptation	Requirement to reduce the exposure and/or vulnerability to the climate change hazard during the design process. This is required when the capacity to adapt is low (i.e., the cost to adapt in the Operate phase compared to the design phase is high.)
Mitigation	Actions taken on green house gas (GHG) emissions to permanently limit or reduce the magnitude and/or rate of long-term climate change.
Natural variability	Variation in climate covering the mean state and in other statistics such as, for example, the occurrence of extreme events, that is due to internal interactions between atmospheric, ocean, land surface and sea ice.
Natural variability period	Period or duration of data required to give a correct estimate of the natural variability in a particular parameter for a particular region.
Offshore	A location where the asset is offshore and is under or surrounded by water. This could include an ocean, inland sea or lake.

Onshore	A location where the asset is on land but sufficiently far from the coast and elevated that it is not influenced by coastal processes including extreme events.
Potential asset risk	Risk to an asset risk that is calculated from the multiplication of the scores for exposure, vulnerability and capacity to adapt. If this score is high, assessment of the climate change hazard severity (at the required probability of exceedence) and inclusion of climate change criteria for design must be undertaken.
Resilience	Capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance.
Risk	The combination of the Consequence of a specific Hazard being released and the Likelihood of it happening. In the context of this DEP, risk is influenced by the interaction of exposure, vulnerability, capacity to adapt, and hazard severity.
Time of emergence	Time it takes for the climate change signal to be visible over the natural variability. Locations where the climate change signal is strong and the natural variability is low will have an earlier time of emergence compared to a location with a high natural variability or low climate change signal.
Vulnerability	Propensity or predisposition to be adversely affected including sensitivity or susceptibility to harm or damage. Within this DEP, the vulnerability rating is linked to the consequence severity rating from the Shell RAM matrix. A vulnerability rated 'high' could lead to a consequence severity 4 or 5, 'Medium' to a consequence severity 2 or 3 and 'Low' and consequence severity 0 or 1.

1.3.3 Abbreviations

Term	Definition
AR5	Fifth Assessment Report
CGB	Concrete Gravity Based
DCAF	Discipline Control and Assurance Framework
ENSO	El Nino Southern Oscillation
EVA	Extreme Value Analysis
FLNG	Floating, Liquid Natural Gas
FPSO	Floating, Production, Storage and Off-take vessel
FSU	Floating Storage Unit
GCM	Global Circulation Models
GHG	Green House Gas
IPCC	International Panel for Climate Change
MPV	Most Probable Value
MSL	Mean Sea Level
NAO	North Atlantic Oscillation
ORS	Opportunity Realisation Standard
RCM	Regional Climate Model
RCP	Representative Concentration Pathways
SBM	Single Buoy Mooring
SRES	The Special Report on Emissions Scenarios
TLP	Tension Leg Platform

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (7).

1.5 SUMMARY OF MAIN CHANGES

This is a new DEP.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

1.9 CLIMATE CHANGE RISK

Climate change risk results from the interaction of asset exposure, asset vulnerability, capacity of the asset to adapt and hazard severity.

The potential asset risk derived from the exposure, vulnerability and capacity to adapt can be accurately derived, however due to the nature of climate change there will always be some uncertainty in the actual risk due to uncertainty in the estimation of the hazard.

The approach to determine climate change hazard severity and provide climate change adjusted design criteria (for use in a Metocean and Ice Reference Document) for new assets can be equally applied to existing assets, when required.

2. OVERVIEW

2.1 BACKGROUND

While there remains uncertainty in projecting future changes in climate and its associated impacts, changes to the earth's climate, including both natural and those that may result from anthropogenic causes, already pose a risk to Shell's operations and assets. Shell's approach to manage this risk involves both mitigation and adaptation.

Climate change mitigation is any action taken directly on GHG emissions to permanently limit or reduce the magnitude and/or rate of long-term climate change and the associated risk to life and asset. This can reduce the level of adaptation required in the future. Mitigation strategies are not covered in this DEP.

Climate change adaptation seeks to lower the risks posed by the consequences of climate change and covers the ability of a system to adjust to climate change, including changes in climate variability and climate extremes. Climate change adaptation aims to:

- moderate the potential damage*
- reduce the sensitivity*
- take advantage of the opportunities and*
- cope with the consequences*

The risk level associated with climate change for a specific asset is determined by:

- The level or severity of the climate change hazard*
- The exposure of the asset to the hazard*
- The vulnerability of the exposed asset to the hazard*
- The capacity of the asset to adapt to the hazard*

This DEP details the combinations of asset type and climate change parameters where action is required. This includes quantification of the climate change hazard severity and design adaptation measures to reduce the climate change risk. The focus is to ensure that new assets are robust to high risk situations where adaptation during the operate phase would be high cost.