

DEP SPECIFICATION

METALLIC MATERIALS - PREVENTION OF BRITTLE FRACTURE IN NEW ASSETS

DEP 30.10.02.31-Gen.

February 2011
(DEP Circular 59/11 has been incorporated)
ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



© 2011 Shell Group of companies

All rights reserved. No part of this publication 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 contains information that is classified as EAR99 and, as a consequence, can neither be exported nor re-exported to any country which is under an embargo of the U.S. government pursuant to Part 746 of the Export Administration Regulations (15 C.F.R. Parts 746) nor can be made available to any national of such country. In addition, the information in this document cannot be exported nor re-exported to an end-user or for an end-use that is prohibited by Part 744 of the Export Administration Regulations (15 C.F.R. Parts 744).

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 recommended 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	5
1.5	SUMMARY OF MAIN CHANGES.....	5
1.6	COMMENTS ON THIS DEP	6
1.7	DUAL UNITS.....	6
2.	BRITTLE FRACTURE	7
3.	DESIGN CODES	8
4.	DETERMINATION OF THE MINIMUM METAL TEMPERATURE AND LOWER DESIGN TEMPERATURE.....	9
4.1	MINIMUM METAL TEMPERATURE (MMT).....	9
4.2	LOWER DESIGN TEMPERATURE.....	9
4.3	SPECIFIC CONSIDERATIONS FOR LIQUEFIED GAS	10
5.	TOUGHNESS REQUIREMENTS	12
5.1	GENERAL	12
5.2	CARBON AND LOW ALLOY STEELS WITH LESS THAN 2 % NICKEL	12
5.3	NICKEL-ALLOYED STEELS	13
5.4	STAINLESS STEELS	14
6.	MATERIALS SELECTION FOR PRESSURE EQUIPMENT	15
6.1	PRESSURE VESSELS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH PD 5500 AND DEP 31.22.10.32-Gen.....	15
6.2	PRESSURE VESSELS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH ASME section VIII DIVISION 1 OR 2 AND DEP 31.22.20.31-Gen.	15
6.3	PRESSURE VESSELS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH EN 13445 AND DEP 31.22.11.32-Gen.....	15
6.4	HEAT EXCHANGERS	16
6.5	ROTATING EQUIPMENT	16
6.6	PROCESS PIPING	17
7.	REFERENCES	18

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the selection and application of steels in order to prevent brittle fracture at low temperature, and is applicable to new assets. This DEP applies irrespective of the contained fluids and covers low temperatures caused both by climate and by the process operating envelope. In addition, specific requirements are given for equipment containing liquefied gas.

Guidelines are given for steel selection on the basis of the Lower Design Temperature for:

- unfired pressure vessels;
- piping, piping components and valves (including control valves);
- rotating equipment.

This DEP shall only be used within the context of the relevant design and construction codes and the corresponding DEPs (see Section 3).

This DEP is not applicable to:

- fired heaters;
- transmission pipelines;
- vertical atmospheric storage tanks;
- steel structures.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the number dated January 2010; see (1.5) regarding the changes.

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 authorization 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 should 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 capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Adiabatic flash temperature (AFT)	The lowest temperature a liquid reaches, when a given quantity of a mixture is adiabatically depressurised to atmospheric pressure.
Atmospheric boiling point (ABP)	The temperature at which the vapour pressure throughout the bulk of the liquid exceeds the atmospheric pressure.
Equipment	In the context of this DEP, any unfired vessel, column, reactor, heat exchanger, pump, compressor, piping or part thereof under internal or external pressure. Fired heaters, vertical atmospheric storage tanks, steel structures and transmission pipelines are excluded from this definition.
General membrane stress	The tensile component of the general primary stress resulting from sustained loadings, such as internal and external pressures, static head, own weight and wind loading. The general membrane stress is averaged over the thickness of the structure and it determines the elastic stored energy in the wall of the equipment. In design or assessment of piping systems, stresses due to thermal constraints contribute to the general membrane stress.
Liquefied gas	A product which is gaseous at ambient temperature and atmospheric pressure, but is maintained in a liquid state by means of pressure or refrigeration, or a combination of the two.
Lowest Ambient Temperature (LAT)	The lowest one day mean ambient temperature on the basis of meteorological data of hourly measurements over the last 20 years, or longer. The LAT shall not be warmer than the lowest ambient temperature to be used for design under the local regulations.
Lower Design Temperature (LDT)	The lowest temperature at which equipment may be subjected to its design pressure; LDT is further described in (4.2).
Minimum Metal Temperature (MMT)	The lowest temperature that equipment may possibly attain; MMT is further described in (4.1).

1.4 CROSS-REFERENCES

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

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2010.

In this revision certain contents that did not constitute requirement or recommendation have been removed and placed in a companion DEP Informative.

In addition, the appendix on brittle fracture assessment of existing equipment has been removed, and is now located in RMP 30.10.02.50-Gen.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of “DEPs on the Web”, available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

**Amended per
Circular 59/11**

Dual units have been incorporated throughout this DEP.

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.