

DEP SPECIFICATION

ONSHORE STEEL STRUCTURES

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design, fabrication and erection of onshore steel structures.

This is a revision of the DEP of the same number dated January 2009; 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 onshore 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 **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

For US and Canada specific definitions refer to [\(APPENDIX D\)](#).

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

1.3.3 Abbreviations

Term	Definition
API	American Petroleum Institute.
ASME	American Society of Mechanical Engineers.
AWS	American Welding Society.
BS	British Standard.
CICIND	International Committee on Industrial Chimneys
DEP	Design and Engineering Practice.
DTI	Direct Tension Indicator
ISO	International Standards Organization.
WPS	Welding Procedure Specification.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the reference section number is shown in brackets (). Other documents referenced by this DEP are listed in (10).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2009. There were major changes to the content of this DEP. All changes are the result of segregating the DEP in to Specification and Informative.

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

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.

2. DESIGN CRITERIA**2.1 GENERAL**

The design of a steel structure shall take into account the following aspects to achieve both a safe and economical design:

- a) local / national building regulations
- b) properties of the materials of construction
- c) corrosion protection
- d) calculated stresses for the members
- e) prevailing conditions of the local environment
- f) details of construction
- g) methods of erection and fabrication, including their effect on cost

The design shall take into account the minimum loads as defined in local building codes, specified project specifications, and operations / maintenance requirements, see Table 2.1 for reference.

For existing facilities, actual loads may be used with prior written approval by the Principal.

Table 2.1 Regional Standards, Specifications, Codes, and Regulations⁽¹⁾

EUROPE (EU) ⁽²⁾	United States of America (US)	Canada (CA)	International
EN 1990	ANSI / AISC 360	CSA S16	ISO 10721-2
EN 1991	AISC Steel Construction Manual	CISC Handbook of Steel Construction	ISO 1461
EN 1993	CBC	NBCC	
EN 1994	IBC	ABC	
EN 1998		OBC	

- NOTES
1. If local standards, specifications, codes and regulations exist for the materials, section properties, design, and test methods covered by this DEP that yield equivalent quality and performance, they shall be substituted only with prior written approval by the Principal.
 2. All Eurocodes shall include National annexes, amendments, corrigendums and references to other codes.

3. DESIGN REQUIREMENTS

3.1 TEMPERATURE RANGE, HIGH AND LOW TEMPERATURES

Additional consideration will be necessary for structures at locations where very high or low temperatures occur.

3.1.1 High Temperatures:

The allowable design stresses of structural steel elements that are continuously exposed to a temperature above 260°C (500°F) shall be reduced in proportion to reductions in yield strength of the steel.

3.1.2 Low Temperatures:

The steel to be selected for cold climate (e.g. arctic) applications shall satisfy the fracture toughness and shall be selected appropriate to the climate in which structure is erected. When the design lowest ambient mean temperature is below 0°C (32°F), specific requirements for Charpy V-test results shall be provided for steel over 25 mm (1 in) thick and those subject to fatigue loading.

Attention shall be paid to dimensioning in view of fatigue of structures and to stresses caused by combined effects of snow and wind loads as well as large temperature variations. High quality corrosion protection shall be of prime importance in most arctic environments.

4. MATERIALS**4.1 GENERAL**

Acceptable materials are listed in Tables 4.1.1 through 4.1.4.

The use of alternative materials not listed in the tables below shall be submitted to the Principal for review and comment. Alternative materials shall be selected in accordance with local codes and regulations, taking weldability and the required finished weldment mechanical properties into consideration. The utilization of the GB (国标 Guo Biao) 150 standard for selection of alternative materials may be considered.

Table 4.1.1 Material Grades for Structural Shapes, Pipe and Tubing

Type	Material Grades Standards ⁽¹⁾
Structural Shapes/ Sections (e.g. W, WT, H, UC, UB, HE)	EU - EN 10025-2 / Euronorm 19, 53 US - ASTM A992 / A992M CA - CSA G40.21-M, Grade 350W CH - GB/T 11263
Rolled Steel Joists (e.g. RSJ, IPN) / Miscellaneous Structural Shapes (e.g. S)	EU - BS 4-1, DIN 1025-1 US - ASTM A992 / A992M, ASTM A36 / A36M CA - CSA G40.21-M, Grade 350W CH - GB/T 706
For elements such as channels shapes, angles, plates, bars and those shapes not available in grades listed in the rows above.	General EU - EN 10025-2 US - ASTM A36 / A36M CA - CSA G40.21-M, Grade, 300W Other materials permitted as indicated below for specific material types: Angles: EU - EN 10056-1 CH - GB/T 706 Plate : CH - GB/T 3274, GB/T 19879-2005
Steel pipe as structural members (hollow round shapes with relatively thicker wall thickness than round tubing).	EU - EN 10210-2 US & CA - ASTM A53 / A53M Type E (welded) or S (seamless), Grade B or ASTM A106 / A106M Grade B CH - GB/T 8162-2008
Structural tubing (hollow sections in round, square, and rectangular shapes).	EU - EN 10210-2 / EN 10219-2 US - ASTM A501 or ASTM A500 Grade B CA - CSA G40.21-M, Grade 350 Class C or H CH - GB/T 6725-2008

NOTES 1. EU = Europe; US = United States of America; CA=Canada, CH=China.

Table 4.1.2 High-Strength Bolt Assemblies

Type	Material Standards ⁽¹⁾
Bolt	EU / International - ISO 4014, ISO 898-1 and ISO 898-2 US and CA - ASTM A325 Type 1 or ASTM A490 / A490M
Washer	US & CA - ASTM F436 / F436 M
Direct Tension Indicator (DTI) Washers ⁽²⁾	US & CA - ASTM F959
Heavy Hex Nut / Thread	EU / International - ISO 4032 / ISO 888 US and CA - ASTM A563 Grade DH

NOTES 1. EU = Europe; US = United States of America; CA=Canada, CH=China.

2. Compressible-washer-type direct tension indicator shall be installed according to the DTI manufacturer's published specifications. DTI, if used, shall be galvanized by the DTI manufacturer requirements. Compressible-washer-type direct tension Indicator are preferred.

Table 4.1.3 Standard Bolt Assemblies

Type	Materials Standards ⁽¹⁾
Bolt ⁽³⁾	EU / International - ISO 4014, Grade 8.8 or equivalent in accordance with ISO 898-1 and ISO 898-2 ⁽²⁾ . US and CA - ASTM A307 Grade A heavy hex
Washer	US and CA - ASTM F436 / F436M
Heavy Hex Nut / Thread	EU / International - ISO 4032 / ISO 888 US and CA - ASTM A563 Grade A

NOTES 1. EU = Europe; US = United States of America; CA=Canada, CH=China.

2. High-strength friction-grip connections, grade 10.9 or equivalent, may be used for transport and / or lifting applications or other special applications if approved by the Principal.
3. High-strength friction-grip (pretension bolts) shall not be used for steel connections that are required for gravity or other sustained load conditions, because of their loss of pre-tension in a fire.

Table 4.1.4 Welding Consumables

Type	Materials Standards ⁽¹⁾
Welding Electrode	EU and US - ANSI / AWS D1.1, ² . CA - CSA W48.1-M, E48018 (E7018)

NOTES 1. EU = Europe; US = United States of America; CA=Canada, CH=China.

2. Low hydrogen with an electrode strength of 400 MPa (58 ksi) minimum yield strength and 70 ksi 480 MPa (70 ksi) minimum tensile strength.