

DEP SPECIFICATION

**DESIGN OF JETTY FACILITIES
(AMENDMENTS/SUPPLEMENTS TO
BS 6349-1, -1.1/ -1.3/ -1.4, BS 6349-2 and BS 6349-4)**

DEP 35.00.10.10-Gen.

February 2017

DESIGN AND ENGINEERING PRACTICE



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PREFACE

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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.

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

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PART I INTRODUCTION

1.1 SCOPE

This DEP specification gives requirements and recommendations for the design and engineering of fixed marine facilities for ships loading and unloading of: crude oil, oil products, LPG/LNG and petrochemical products.

Requirements for the design of topworks including piping, product transfer arms and other mechanical and electrical installations are not explicitly included in this DEP. Requirement for offshore structures are listed in separate DEPs, such as DEP 37.19.00.10-Gen.

Requirements for the design of buoy-moored marine facilities such as single point moorings and other offshore loading facilities are outside the scope this DEP.

Part III of this DEP is based on:

BS 6349-1:2000	Maritime structures - Code of practice for general criteria
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Part IV of this DEP is based on:

BS 6349-1-1:2013	Maritime Works - General – Code of practice for planning and design for operations
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Part V of this DEP is based on:

BS 6349-1-3:2012	Maritime Works - General – Code of practice for geotechnical design
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Part VI of this DEP is based on:

BS 6349-1-4:2013	Maritime Works - General – Code of practice for materials
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Part VII of this DEP is based on:

BS 6349-2:2010	Maritime Works - Code of practice for the design of quay walls, jetties and dolphins
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Part VIII of this DEP is based on:

BS 6349-4:2014	Maritime Works - Code of practice for design of fendering and mooring systems
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Parts III through VIII of this DEP amend, supplement and delete various clauses of BS 6349-1, BS 6349-2 and BS 6349-4. Parts III through VIII follow the clause numbering of BS 6349-1, BS 6349-2 and BS 6349-4 for easy reference.

All clauses of BS 6349-1, BS 6349-2 and BS 6349-4 not modified by this DEP remain valid as written.

This is a revision of the DEP of the same number dated February 2015; 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 constitute access to any standards, 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, liquefaction, 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 or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

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

In BS 6349-1,-2 and -4, the term **Vendor** is used. In this DEP, the term **Vendor** shall be understood to mean the Manufacturer/Supplier.

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.

The word **may** indicates a permitted option.

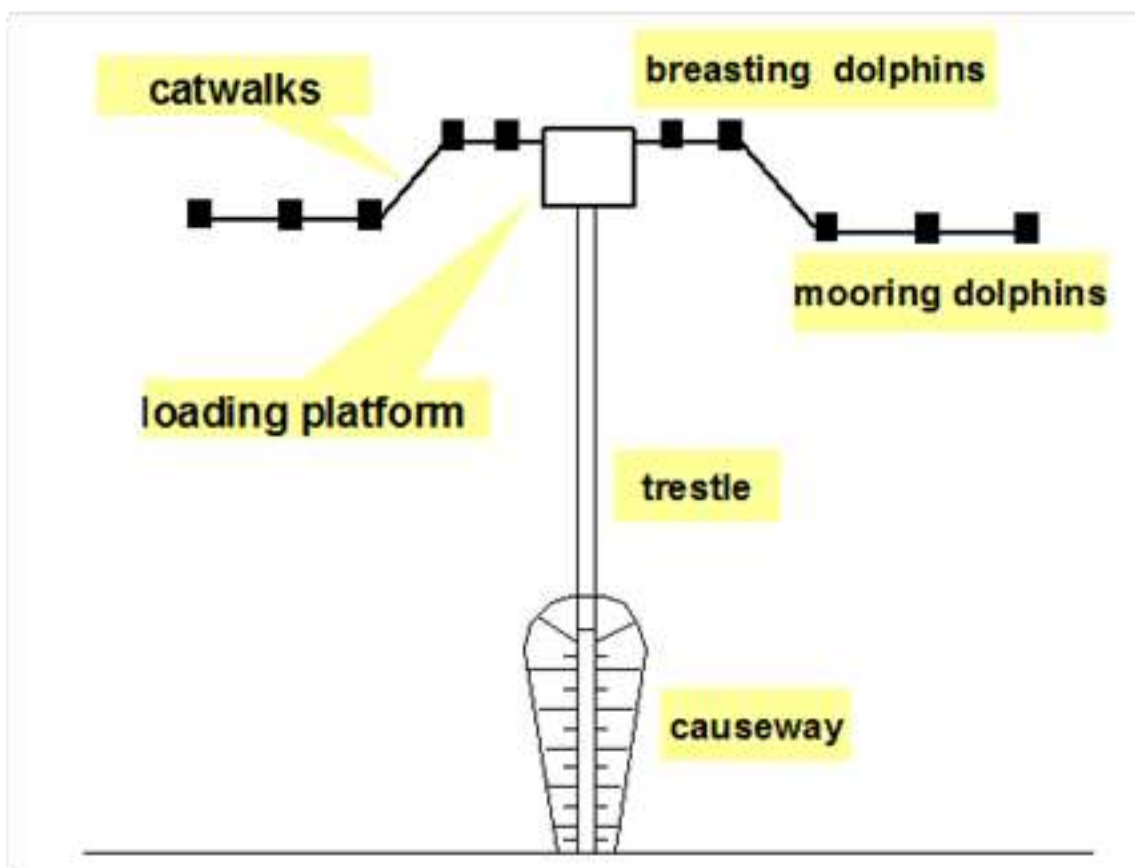
1.3.2 Specific definitions

Terms and definitions are given in BS 6349-1-1:2013 Section 3.

Term	Definition
Berth	A location at which a ship can be held in position by means of mooring lines and/or chains and fendering. The last phase of the approach of a ship (“...to berth a ship...”).
Berth monitoring systems	Equipment to monitor the operation of the berth in service and to assist in berthing, de-berthing. Such systems may include docking aids, mooring line load measurement and recording systems and systems for recording and making available in real time metocean conditions at the berth and approaches.
Breakwater	A structure designed to provide shelter to the berth from waves and currents.
Capital dredging	Dredging operations which are part of the construction/ expansion of the harbour/jetty to create sufficiently deep water for the intended purpose.
Catwalks	A structure providing pedestrian access to a dolphin/ platform.
Causeway	A solid, closed coastal structure (earth or rock dam or caissons) often used to link the shoreline to the root of the trestle across shallow water.
Docking Aid	System for measurement and display of velocity and position/orientation of a ship during the berthing operation.
Dolphin	An isolated structure or strong point used either to: • manoeuvre a ship (turning dolphin), or to • secure a ship and prevent it from moving away from a berth due to wind, wave or current action (mooring dolphin), and/or to • take the impact of a berthing ship and to hold it when being pushed against a berth by wind, waves or current (breasting or berthing dolphin).
Fender Systems	Provision primarily to absorb the berthing energy exerted by a berthing ship, and secondly to resist loads applied from a moored ship as part of the mooring system, keeping the ship in place during loading/unloading operations.
Jetty	A fixed marine structure providing a berth or berths at some distance from the shore. It can be linked to the shore by an approach structure or be an island berth with product transfer by subsea pipeline. The approach structure usually comprises a causeway and/or a trestle as defined herein although other forms of construction are possible.

Term	Definition
Jetty topworks	All equipment, utilities, piping and appurtenances installed on the jetty (loading platforms, trestles) required for or in support of loading/unloading of the ship (incl. personnel, stores etc.), transferring the cargo to the shore and related safety installations. Including but not necessarily limited to: • Gangway towers • Loading arms and/or equipment • Fixed cranes • Fire pumps • Piping • Fire monitors • Berth monitoring systems
Life cycle cost	The cumulative cost of a facility, which includes the costs of planning, construction, maintenance, decommissioning and financing.
Loading platform	Fixed platform directly adjacent to the berthing line capable of accommodating the relevant equipment, piping and appurtenances required for loading or unloading the ship (incl. personnel and stores) including related safety installations. For smaller vessels the loading platform can also be used as berthing and mooring point.
Maintenance dredging	Dredging operations that are required to keep sufficiently deep water for the intended purpose during the operating phase.
Marine facilities	General description encompassing all facilities required to receive ships at a marine terminal or offshore including but not limited to fixed marine facilities, single point mooring facilities, and (offshore) loading structures.
Mooring equipment	Bollards and quick release hooks (including capstans, base structure, fairleads, rings and auxiliary) installed on the mooring and breasting dolphin or loading platform to secure a vessel.
Navigation	Moving a ship along a defined course.
Navigation aids	Facilities to assist in the navigation process, such as buoys, landmarks, lights, radar beacons and systems, etc.
Operating limits	The maximum combination of environmental conditions in which marine operations can proceed (loading, unloading, berthing, arrival and departure) as defined in the facility's operating procedures.
Port	A harbour or place by the sea, or by a river or other waterway, where ships and boats can dock, load, and unload.
Trestle	A piled multi-span bridge structure connecting the loading platform to the shore or causeway to provide vehicular or pedestrian access and/or to support pipes or conveyors.

Figure 1 Nomenclature for jetty components



1.3.3 Abbreviations

The following abbreviations are used in this DEP. Other abbreviations are defined at the first place of use.

Term	Definition
BDP	Basic Design Package
BFD/BOD	Basis for/of Design
CIRIA	Construction Industry Research and Information Association (UK)
CUR	Centre of Civil Engineering Research and Codes (The Netherlands)
DMA	Dynamic Mooring Analysis
EAU	Empfehlungen des Arbeitsausschusses "Ufereinfassungen"; (Germany) Recommendations of the Committee for Waterfront Structures, Harbours and Waterways
EPC	Engineering, Procurement and Construction
FEED	Front End Engineering and Design
ISGOTT	International Safety Guide for Oil Tankers and Terminals
OCIMF	Oil Companies International Marine Forum
PIANC	Permanent International Association for Navigation Conferences, which now refers to itself as "The World Association for Waterborne Transport Infrastructure"
ROM	Recomendaciones Obras Maritimas (Spanish Maritime Works Recommendation)
SIGTTO	Society of International Gas Tanker and Terminal Operators Ltd.

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 directly referenced in this DEP are listed in (Part IX).

Listed in (Part X) are documents on which certain requirements in this DEP have been based. In the text of this DEP, such references are identified by [Ref. x], where x denotes the reference number included in (Part X).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2015. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced shall/should, assigned numbers to Tables and Equations.

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://swwww.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.

PART II GENERAL REQUIREMENTS

1.1 GENERAL

Parts III through VIII of this DEP are written as amendments and supplements to BS 6349-1, BS 6349-2 and BS 6349-4 as follows:

Part III	BS 6349-1:2000	Maritime Works - General – Code of practice for materials
Part IV	BS 6349-1.1:2013	Maritime structures - Code of practice for general criteria
Part V	BS 6349-1-3:2012	Maritime Works - General – Code of practice for planning and design for operations
Part VI	BS 6349-1-4:2013	Maritime Works - General – Code of practice for geotechnical design
Part VII	BS 6349-2:2010	Maritime Works - Code of practice for the design of quay walls, jetties and dolphins
Part VIII	BS 6349-4:2014	Maritime Works - Code of practice for design of fendering and mooring systems

Wherever reference is made to BS 6349-1, BS 6349-2 and BS 6349-4, it is intended to mean BS 6349-1:2000, BS 6349-1.1:2013, BS 6349-1-3:2012, BS 6349-1-4:2013, BS 6349-2:2010, and BS 6349-4:2014 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of BS 6349-1, BS 6349-2 and BS 6349-4 has been used throughout Part III through VIII of this DEP.

1. Clauses in BS 6349-1, BS 6349-2 and BS 6349-4, which are not mentioned in this DEP, shall remain valid as written.
2. Refer to DEP 34.00.01.30-Gen. and the amendments and supplements to BS 6349-2 for Structural design and engineering of jetties.
3. Reference to structural design to BS EN Eurocodes in BS 6349-2 is amended by this DEP and shall include the requirements of DEP 34.19.20.31-Gen. for reinforced concrete structures and DEP 34.28.00.31-Gen for Onshore steel structures.

1.2 ALTERNATIVE CODES OF PRACTICE

1. For countries that do not adopt BS 6349-1, BS 6349-2 and BS 6349-4, alternative national codes and design standards that meet the minimum requirements of those of BS 6349-1, BS 6349-2, BS 6349-4 and this DEP shall be used.
2. For the US, ASCE Standard 61-14: Seismic Design of Piers and Wharves shall be used.

**PART III AMENDMENTS/SUPPLEMENTS TO BS 6349-1 2000 MARITIME STRUCTURES –
PART 1 CODE OF PRACTICE FOR GENERAL CRITERIA**

Section 4. Sea state

21 Wave characteristics

21.1 Wave forms

Replace in third paragraph, last sentence:

For certain applications in these situations sinusoidal wave theory or solitary wave theory can give a better idealization of the wave behaviour than sinusoidal theory.

with:

1. Wave characteristics shall be determined with reference to Clause 21.2 of BS 6349-1:2000.
 - a. In shallow waters, except for straight coastlines with a gentle bathymetry, parallel depth contours and uniform wave fields, the evaluation of wave characteristics shall be carried out by physical or comprehensive mathematical modelling, which is based on streamline function theories, such as the Rienecker-Fenton theory [Ref. 4].

21.3 Sea state properties

21.3.8 Return period and design wave condition

Add at the end of the last paragraph:

1. Fixed coastal structures designed deterministically according to BS 6349-2 and (Part VII) of this DEP shall be designed on the basis of the wave conditions for extreme events of return period set out in Table 21.1 below in this DEP Specification.
2. Design shall be based on the most adverse combination of extreme wave and water level conditions of the specified storm event return period:
 - a. The joint probability analysis of wave conditions shall be evaluated from extreme low to extreme high still water levels (refer to Clause 37 in BS 6349-1:2000).
3. In the absence of a site-specific joint probability study, extreme wave, wind and surge elevation shall be:
 - a. assumed to be fully correlated and,
 - b. the independently assessed extreme values for the specified return period considered to act simultaneously.
4. Wind loads on maritime structures shall be calculated according to EN 1991-1-4, which is based on a return period of 50 years.

Refer also to Clause 34 in BS 6349-1:2000 for gust values.

Table 21.1 Return periods of design extreme wave conditions

Design working life category	Facility usage and damage consequence description	Indicative design working life (years)	Return period of design wave conditions (years)	
			Persistent Design Situation (Ultimate Limit State)	Accidental (Overload) Design Situation (Ultimate Limit State)
1	Temporary structures, materials offloading facility or non- critical structures where loss or damage would not present a high threat to plant operations.	10	25	-
2		25	50 ⁽¹⁾	-
2	Jetties or fixed structures for loading or offloading of hydrocarbons or petrochemicals where loss or damage would have a major impact on plant operations.	25	50 ⁽¹⁾	500 ⁽²⁾
3		50	100	500 ⁽²⁾
1. The value for the return period is taken as 50 years is in line with the standard recommended value in BS 6349-1 (refer to Clauses 37, 38 and 39) for general marine infrastructure and consistent with Eurocode limit state partial factor design. If designing structures to API RP 2A, the use of a return period equal to several times the design working life of the facility with a minimum of 100 years is recommended for permanently manned structures for the oil and gas industry. 2. This condition is required to mitigate the risk of disproportionate damage of business critical infrastructure under low probability events, particularly if slamming forces are experienced by jetty deck structures.				

22 Offshore wave climate

22.2 Wave prediction

22.2.1 General

Replace the last sentence in the second paragraph with:

- Such wave forecasts shall be supplemented and validated with wave observations made from ships [Ref. 18], satellites and, when required by the Principal, with direct wave recordings at the location of interest (refer to Clause 26 in BS 6349-1:2000).

22.3 Wave decay and swell

Delete the last two sentences of the first paragraph and replace with:

The global wave hindcast models include information on the decay and propagation of swell waves outside the fetch areas.

- A wave recorder shall be installed at the site of interest to validate the information taken from the global wave models unless otherwise agreed with the Principal.
 - In such cases the range of wave periods in the spectral analysis should be set in line with the anticipated maximum, depending on the fetch length.

24 Long waves

24.4 Tsunamis

Add at end of paragraph:

1. Following a risk assessment, a dedicated assessment of possible design water levels and run-up for tsunamis shall be carried out in specialist studies.
 - a. Refer to DEP 34.00.01.10-Gen. for details on required tsunami hazard assessments.

26 Wave recording and analysis

26.1 Existing data sources

Add at end of paragraph:

1. Refer to other international and local sources of data, where available.

26.2 Site measurements

Replace in sixth paragraph, last sentence:

Recording periods of 10 min to 15 min at intervals of 8 h are usually sufficient for derivation of design storms or swell wave data.

with:

Recording periods of 10 min to 15 min at a minimum interval of 3 h are usually sufficient for derivation of design storms or swell wave data.

26.3 Wave recorders

26.3.4 Directional systems

Add at the start of the first paragraph:

1. Wave recording shall include the measurement of direction of waves and swells.

27 Extrapolation of wave data

27.2 Extrapolation to extreme wave conditions

27.2.1 Reliability of extrapolations

Add to the end of the last paragraph:

1. If extrapolations are carried out on the basis of a 12-month measurement period cycle only, hindcast studies or other studies shall be carried out to:
 - a. ascertain whether the considered year is representative;
 - b. develop a method for determining an appropriate approach to extrapolation to extreme values.
2. For regions subject to the influence of tropical and extra-tropical cyclones (also referred to locally as hurricanes and typhoons), a site or region specific cyclone study shall be carried out to determine extreme values of wave conditions.

29 Harbour response

29.5 Physical models

Replace in second paragraph:

The physical model has the advantage over mathematical models because it is able to determine harbour response in the presence of the combined effects of wave diffraction, refraction and reflection. In addition, because it is a direct attempt to reproduce reality on a smaller scale, it automatically describes various secondary physical effects, which can only be added to the indirect mathematical model once they are identified and described theoretically.

with:

Because it is a direct attempt to reproduce reality on a smaller scale, the physical model has the advantage that it can describe various secondary physical effects, which can only be added to the indirect mathematical model once they are identified and described theoretically. This is provided that the model set-up correctly represents the relevant features of the site, such as bathymetry, bottom friction, extent of area, wave conditions, etc.

31 Acceptable wave conditions for moored ships

31.3 Methods for determining acceptable sea states

31.3.1 General

Add to last paragraph:

1. Analytical methods shall not be used for assessment of the non-linear behaviour of a moored ship in shallow waters, unless these methods have been proven to be accurate.

31.3.3 Analytical methods

Delete this entire clause.

31.3.4 Mathematical models

Replace paragraph 2 (starting with "If the assumption is made....."), para 3, para 4 and para 5 with:

1. Mathematical models are available which can deal with the non-linear characteristics of mooring lines, hydrodynamic damping and interacting wave fields. Such models are based on a time-domain analysis of the response, and shall be used in the evaluation of moored ship dynamic response.
 - a. Quasi-static models shall only be used for sheltered sites (i.e., no wave action) and are subject to approval by the Principal.
2. For complex conditions where mathematical models do not accurately allow for accurate simulation of dynamic response of moored ships, then physical modelling shall be carried out to evaluate dynamic response.

Conditions in which mathematical models are inaccurate include:

- shallow water (low under keel clearance);
- sloping seabed;
- strongly refracting or diffracting incident wave fields.

31.4 Acceptable ship movements

31.4.2 Limits imposed by safety

Add to the first paragraph:

1. For berths for oil and gas tankers, Operating Limits for wind, waves and currents shall be determined so as not to exceed the acceptable mooring line forces, as set out in the OCIMF Mooring Equipment Guidelines 3rd Edition (MEG3) [Ref. 5] as follows:
 - a. The mooring facilities provided at the berth shall permit the largest ship which is to be accommodated to remain safely moored alongside in the maximum environmental Operating Limits established for the specific site;
 - b. The wind and current forces on the ship shall be calculated for the wind and current conditions under which the ship could remain moored at the berth, using the procedures covered in Section 2 of [Ref. 5]:
 - i. At exposed locations, the impact of dynamic wave load effects shall be considered in addition to the calculation of static loads;
 - ii. Most probable maximum (MPM) loads shall be assessed when establishing allowable load criteria for moorings (see Section 2.5 of [Ref. 5]).
 - c. Allowable loads in any wire mooring line should not exceed 55% of its Minimum Breaking Load (MBL):
 - i. For synthetic lines, except polyamide (nylon), loads should not exceed 50% of the line's MBL;
 - ii. For polyamide, loads should not exceed 45% of the line's MBL to allow for strength loss when wet.

Add to the last paragraph:

2. The values indicated in Table 2 in BS 6349-1:2000 shall not be used for ship sizes above the indicated value of 8000 DWT.

31.4.3 Limits imposed by cargo handling

Delete in Table 3 the row for gas tankers.

Add to second paragraph:

1. Loading arm design shall be based on DEP 31.06.15.10-Gen., which are based on the standard practice of defining a required loading arm envelope on the basis of envisaged vessel excursions rather than imposing maximum motion criteria.
 - a. The required input on vessel excursions shall follow from a moored ship evaluation under maximum operational conditions when berthed and will thereby supercede the values in Table 3.