OFFSHORE STANDARD

DNV-OS-H202

Sea transport operations (VMO Standard - Part 2-2)

OCTOBER 2015

The electronic pdf version of this document found through http://www.dnvgl.com is the officially binding version

DET NORSKE VERITAS AS

FOREWORD

DNV is a global provider of knowledge for managing risk. Today, safe and responsible business conduct is both a license to operate and a competitive advantage. Our core competence is to identify, assess, and advise on risk management. From our leading position in certification, classification, verification, and training, we develop and apply standards and best practices. This helps our customers safely and responsibly improve their business performance. DNV is an independent organisation with dedicated risk professionals in more than 100 countries, with the purpose of safeguarding life, property and the environment.

DNV service documents consist of among others the following types of documents:

— *Service Specifications.* Procedural requirements.
— *Standards.* Technical requirements.
— *Recommended Practices.* Guidance.

The Standards and Recommended Practices are offered within the following areas:

A) Qualification, Quality and Safety Methodology
B) Materials Technology
C) Structures
D) Systems
E) Special Facilities
F) Pipelines and Risers
G) Asset Operation
H) Marine Operations
J) Cleaner Energy
O) Subsea Systems
U) Unconventional Oil & Gas

Any comments may be sent by e-mail to *rules@dnvgl.com*

CHANGES – CURRENT

General

This is a new document.

Det Norske Veritas AS, company registration number 945 748 931, has on 27th November 2013 changed its name to DNV GL AS. For further information, see www.dnvgl.com. Any reference in this document to "Det Norske Veritas AS" or "DNV" shall therefore also be a reference to "DNV GL AS".

General

This is a new document in a series of documents replacing the DNV "Rules for Planning and Execution of Marine Operations" (1996/2000); this standard replaces Pt.2 Ch.2 and Ch.3. Extensive revisions and/or amendments have been made, with the following main changes:

- As chapters have been merged, the layout is new.
- Technical requirements have been aligned with "Noble Denton guidelines", i.e. 0030/ND.
- FLS (fatigue) requirements for transports are included.
- The seafastening requirements have been described in considerably more detail.

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SECTION 1 INTRODUCTION

1.1 Application

1.1.1 General

1.1.1.1 This standard, DNV-OS-H202 provides requirements, recommendations and guidance for sea transport operations. Typical operations are towing of barges, vessels and self-floating objects as well as ship transportation of special cargoes.

Guidance note 1:

Special cargo is defined as cargo that is not considered adequately covered by the ship's standard transport procedures by any stakeholder.

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Guidance note 2:

Additional requirements and recommendations and positioning of Mobile Offshore Units are given in DNV-OS-H203.

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1.1.2 Complementary standards

1.1.2.1 DNV offshore standards covering marine operations, i.e. DNV-OS-H101, DNV-OS-H102 and DNV-OS-H201 through DNV-OS-H206, are collectively referred to as the VMO Standard.

Guidance note:

The "VMO Standard" supersedes and replaces "DNV - Rules for Planning and Execution of Marine Operations".

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1.1.2.2 General recommendations for planning of, loads associated with and design of marine operations are given in DNV-OS-H101 and DNV-OS-H102.On and offloading of the transported objects (cargoes) are generally covered in DNV-OS-H201 and DNV-OS-H205. However, see also [7.4] for on/offloading of HTV.

1.1.2.3 Additional guidance regarding the sea transport of decommissioned objects may be found in DNV-RP-H102.

1.1.3 Conditions and alternative methods

1.1.3.1 The objectives of this Standard are stated in DNV-OS-H101 Sec.1 A.

1.1.3.2 The general conditions for use of this Standard are stated in DNV-OS-H101 Sec.1 B200.

1.2 References

1.2.1 Numbering and cross references

1.2.1.1 Table 1-1 defines the numbering system used throughout this standard, in comparison with that adopted in some of the DNV-H series of offshore standards that have been published to date. See Table 1-1.

1.2.1.2 The text in this standard includes references to the documents listed in Table 1-2. If indicated where the references are given, the referenced text shall be considered as part of this standard.

Table 1-1 Numbering

Level	*Numbering*	*Numbering in some published DNV-H standards*
Sections	1	Sec. 1, 2, 3…
Sub-sections	1.1	A., B., C.….
Paragraphs	1.1.1	A 100, A 200, A 300…
Items	1.1.1.1	101, 102.., 201, 202.., 301, 302…

1.2.1.3 Requirements herein are based on the document revisions listed in Table 1-2; however, the latest revision shall normally be applicable, unless otherwise agreed.

Guidance note:

The agreement should be made (normally through contracts) between the parties involved, typically Company, Contractors and MWS.

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1.2.2 Normative references

Table 1-2 Normative references

Reference	*Revision*	*Title*
DNV-OS-H101	Oct. 2011	Marine Operations, General (VMO Standard Part 1-1)
DNV-OS-H102	Jan. 2012	Marine Operations, Design & Fabrication (VMO Standard Part 1-2)
DNV-OS-H201	Apr. 2012	Load Transfer Operations (VMO Standard Part 2-1)
DNV-OS-H203	Feb. 2012	Transit and Positioning of Offshore Units (VMO Standard Part 2-3)
DNV-OS-H204	Nov. 2013	Offshore Installation Operations (VMO Standard Part 2-4)
DNV-OS-H205	Apr. 2014	Lifting Operations (VMO Standard Part 2-5)
DNV-OS-H206	Sep. 2014	Subsea Operations (VMO Standard Part 2-6)
DNVGL-OS-C101	Jul. 2015	Design of offshore steel structures, general - LRFD method

1.2.2.1 The documents listed in Table 1-3 include information that, through references in this text, clarify and indicate acceptable methods of fulfilling the requirements given in this standard.

1.2.2.2 The latest revision of the informative references should normally be used.

1.2.3 Informative references

Table 1-3 Informative references

Reference	*Title*
DNV-RP-H101	Risk Management in Marine and Subsea Operations
DNV-RP-H102	Marine Operations during Removal of Offshore Installations
DNV-RP-H103	Modelling and Analysis of Marine Operations
DNV-RP-C205	Environmental Conditions and Environmental Loads
DNV-RP-A203	Qualification Procedure for New Technology
DNV SfC 2.7-3	DNV Standard for Certification No 2.7-3 – Portable Offshore Units
DNV Ship Rules	DNV Rules for Classification of Ships
DNV CN 08	DNV Classification Note 8 - Conversion of Ships
0001/ND	GL Noble Denton – General Guidelines for Marine Projects – 0001/ND
0030/ND	GL Noble Denton – Guidelines for Marine Transports – 0030/ND
EN 1993-8	Eurocode 3, Design of steel structures, Part 1-8: Design of joints
EN 13411-4	Terminations for Steel Wire Ropes, Part 4: Metal and Resin Socketing
IMO Res. A.714(17)	IMO Resolution A.714(17) 1991 Code of Safe Practice for Cargo Stowage and Securing
IMO MSC/Circ. 884	IMO Ref. T1/3.02, MSC/Circ.884 - Guidelines for Safe Ocean Towing

1.3 Definitions

1.3.1 Verbal forms

1.3.1.1 Verbal forms of special importance are defined as indicated below in this standard.

Table 1-4 Verbal forms

Term	*Definition*
shall	verbal form used to indicate requirements strictly to be followed in order to conform to the document
should	verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required
may	verbal form used to indicate a course of action permissible within the limits of the document

1.3.2 Terminology

1.3.2.1 Terms of special importance are defined as indicated below in this standard. See also DNV-OS-H101 for general terms.

Table 1-5 Terms

Term	*Definition*
benign weather areas	sea areas as defined in 0001/ND
bollard pull	certified continuous static towing force applied by tug, i.e. continuous tow line force The certified bollard pull should be based on testing carried out according to the certifying body's (standard) procedure.
certified item	item with a capacity or property certified by a recognised body
coastal towing	towing in waters less than 12 nautical miles off the coastline
grillage	structural load distributing elements installed to avoid excessive local loads
heavy transport vessel	a submersible barge or vessel carrying heavy object(s) on deck The objects are loaded on/off the carrier in float-on/float-off operations. (Note that the term HLV [Heavy Lift Vessel] is/was also used for this kind of vessel).
inshore towing	towing in sheltered waters
internal seafastening	securing of loose items within the handled object
multi-barge towing	transfer at sea, using tugs, from one location to another of an object resting on two or more barges
object	structure/vessel subjected to one or several of the operations defined in this standard
offshore towing	towing in waters more than 12 nautical miles off the coast
seafastening	structural elements providing horizontal and uplift support of an object during sea transport operations
safe condition	a condition where the object is considered to be exposed to a "normal" risk of damage or loss
self-floating tow	transfer at sea from one location to another of an object supported by its own buoyancy and pushed/ pulled by tugs
ship transportation	transfer at sea from one location to another of an object on board a conventional vessel or supply vessel
unit	the assembled configuration of transport vessel(s) and object(s) to be transported
weather restricted transport/tow	a transport (or tow) with a specific weather restriction, normally the maximum allowable significant wave height
weather routed transport/ tow (weather routing)	a transport (or tow) with some (specific) recommendations that are intended to reduce the risk in the case of deteriorating/bad weather conditions Note that all transports will, as default, to some extent be weather routed by the captain/ tow master.

1.3.3 Abbreviations and symbols

1.3.3.1 The list below defines symbols used in this standard.

Table 1-6 Abbreviations and symbols

Abbreviation/ symbol	*Definition*
A_{exp}	exposed cross-sectional area in m^2
ALS	accidental limit state
a_x	accelerations in vessel longitudinal direction
a_y	accelerations in vessel transverse direction
a_z	accelerations in vessel vertical direction
B	breadth
BF	Beaufort wind scale
BP	static tug bollard pull in tonnes
C_b	block coefficient
CoG	centre of gravity
ETA	estimated time of arrival
ETD	estimated time of departure
FLS	fatigue limit state
FPSO	floating production, storage and offload vessel
F_{TD}	design load for towing arrangements

Table 1-6 Abbreviations and symbols (Continued)

Abbreviation/ symbol	*Definition*
F_{TR}	towline pull required
g	acceleration of gravity
GM	initial metacentric height
H_{max}	maximum anticipated wave height
H_s	significant wave height
HTV	heavy transport vessel (most commonly denoted HLV – heavy lift vessel – earlier)
L	rule ship length, see DNV Ship Rules, Pt.3 Ch.1 Sec.1 B100. If not known, L_{PP} (length between forward and aft perpendicular) may be used in the standard acceleration formulas
LAT	lowest astronomical tide
LOA	tug overall length
LRFD	load- and resistance factor design
$L_{towline}$	length of towline
MBL	certified minimum breaking load
$MBL_{towline}$	towline MBL
OP_{LIM}	operational limiting criteria, see DNV-OS-H101 Sec.4 B600
OP_{WF}	forecasted (monitored) operation criteria
SLS	serviceability limit state
SWL	certified safe working load
T	draft
T_R	operation reference period
Tz	mean zero up-crossing period
ULS	ultimate limit state
v	towing speed
V_c	current velocity
V_W	mean wind velocity
WLL	working load limit
Z quality	steel grade of proven through-thickness properties
α_{int}	interaction efficiency factor
η	shape factor
γ_{Mw}	material factor for welds
γ_{TE}	tug efficiency factor

SECTION 2 GENERAL REQUIREMENTS

2.1 Planning

2.1.1 General

2.1.1.1 Planning, including the design process, documentation and risk management, for sea transports shall comply with the requirements and philosophies given in DNV-OS-H101 Sec.2.

Guidance note:

The documentation associated with the above should be commensurate with the operational complexity and experience of those parties involved in any given operation.

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2.1.2 Operation period

2.1.2.1 The planned operation period (T_{POP}) and the corresponding required operation reference period, T_R, defined in DNV-OS-H101 Sec.4 B, should be thoroughly evaluated at an early stage.

2.1.2.2 The start and end points for a sea transport operation shall be at “safe conditions” and they should be clearly defined.

Guidance note:

See DNV-OS-H101 Sec.2 A101 for the definition of a “safe condition”.

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2.1.2.3 A sea transport operation may consist of several sub-operations. This shall be thoroughly considered in the overall planning of the operation.

Guidance note:

E.g. a sea transport operation could include several transport legs. In addition, it could be required to include on- and/or offloading (or at least mooring in the receiving port) in the operation from one “safe condition” to another.

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2.1.2.4 The (sub) operation(s) should be defined as either weather restricted or unrestricted, see [2.1.3] and [2.1.4].

2.1.3 Weather restricted transports

2.1.3.1 Weather restricted transport operations may be designed for specified environmental criteria, see DNV-OS-H101, Sec.4 B500.

2.1.3.2 Weather restricted transports shall seek shelter if the actual situation or weather forecast(s) indicates that the operational limitations may be exceeded. See [2.3.4].

2.1.3.3 Operation procedures (see [2.2.4]) describing in detail the actions required for different weather (forecasted) conditions shall be established.

2.1.3.4 It is not recommended to specify heading control in order to reduce the design accelerations for weather restricted transports. If heading control anyhow is specified, the operations limitations shall duly reflect this. See also [2.1.5] and especially [2.1.5.5].

2.1.4 Unrestricted transports

2.1.4.1 Unrestricted transport operations are designed for unrestricted environmental conditions, see DNV-OS-H101 Sec.4 B800. Note also requirements for tow out given in [4.4.2].

2.1.5 Heading controlled transports

2.1.5.1 Normally, the design weather during transport shall be considered for all directions, see DNV-OS-H102, Sec.4 B200. However, some transports may be planned as heading controlled if manoeuvrability and reliable backup and/or the redundancy of propulsion system(s) can be documented, see [2.1.5.4].

2.1.5.2 The following design conditions apply for a heading controlled transport:

— 100% of the design weather to be applied for ULS in head seas +/- 30 degrees.
— The acceptable weather conditions to be used for ULS in all other directions have to be assessed and the implied operational restrictions should be thoroughly described in the transport manual.
— All sea directions not analysed for the design weather in ULS shall normally be considered as accidental cases (ALS), but see note 6) to Table 3-1 in DNV-OS-H102. ALS design approach and load factors should be selected according to DNV-OS-H102 Sec.5 D200.

— Regarding FLS see [3.4].

Guidance note:

The above design conditions are normally fulfilled by applying the wave heights indicated in the table below in ULS design.

Incident angle (Head Seas = 0°)	Applicable Hs in ULS, as % of design sea state
0° +/- 30°	100%
+/- (30° - 60°)	Linear interpolation between 100% and 80%
+/- 60°	80%
+/- (60° - 90°)	Linear interpolation between 80% and 60%
+/- 90°	60%
+/- (90° - 120°)	Linear interpolation between 60% and 80%
+/- 120°	80%
+/- (120° - 150°)	Linear interpolation between 80% and 100%
+/- (150° - 180°)	100%

2.1.5.3 Planning for heading control with single tug towages, or voyages by vessels with non-redundant propulsion systems is not considered feasible. Nor should heading control be applied to transports crossing sea areas with dominant beam/quartering sea directions or in tropical cyclone sea areas during a storm season.

2.1.5.4 Heading control may be applied for the following sea transports:

a) Manned, multiple tug towages, where after breakdown of any one tug or breakage of any one towline or towing connection, the remaining tug(s) still comply with the requirements in [4.3.4].

b) Sea transports by self-propelled vessels with redundant propulsion systems.

Guidance note 1:

A vessel with a redundant propulsion system is defined as having, as a minimum:

— 2 or more independent main engines
— 2 or more independent fuel supplies
— 2 or more independent power transmission systems
— 2 or more independent switchboards
— 2 or more independent steering systems, or an alternative means of operating a single steering system (but excluding emergency steering systems that cannot be operated from the bridge)
— the ability to maintain any desired heading in all conditions up to and including the design storm, taking account of the windage of the cargo.

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Guidance note 2:

All the documentation required to establish whether or not a vessel can be considered to have a redundant propulsion system should be made available.

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2.1.5.5 The considered operation period (T_R) for heading controlled transports shall be based on the longest transport route that could be required.

Guidance note:

Heading control may/will restrict the feasible sailing courses. Hence, the length of the transport route may increase considerably. The feasibility of weather restrictions/routing should be documented considering this.

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2.1.5.6 Operation procedures (see [2.2.4]) describing in detail the actions required for different weather (forecasted) conditions, including wave directions, considering the transport route and schedule shall be established.

2.2 Documentation

2.2.1 General

2.2.1.1 General documentation requirements are given in DNV-OS-H101 Sec.2 B.

2.2.2 Design documentation

2.2.2.1 All the required (see Sec.3) analyses and calculations shall be properly documented by design reports and design drawings.

2.2.2.2 The design documentation shall clearly state all the assumptions that need to be confirmed before and during the transport operation.

2.2.2.3 As a minimum adequate design documentation covering the following is normally required:

— environmental conditions
— vessel motions/accelerations
— loads
— object (external) seafastening
— internal seafastening for "heavy" objects
— strength of the transported object(s)
— vessel strength
— vessel stability
— towing resistance (for towing)
— towing equipment (for towing).

2.2.3 Equipment, fabrication and vessels

2.2.3.1 An acceptable standard of equipment, fabrication and vessels shall be documented by:

— certificates
— test, survey and NDE reports
— classification documents.

Guidance note:
See e.g. DNV CN 08 Sec.3 - Mobilization with Temporary Installations and Sec.4 - Mobilisation for Single Voyage.

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2.2.3.2 The documentation (copies) should normally be submitted for review as soon as possible. Under any circumstances, all relevant documentation (originals) shall be available for review before the start of the transport operation.

Guidance note:
In order to avoid delays, as much documentation as possible should be presented in due time before the operations, leaving the amount of documentation to be reviewed on site to a minimum.

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2.2.4 Operation procedures

2.2.4.1 An operation manual covering all relevant aspects of the planned transport operation shall be prepared. See DNV-OS-H101 Sec.4 G200.

2.2.4.2 Weather routing actions shall be properly described, see e.g. [2.3.3.2].

2.2.4.3 The operation shall be properly logged. See DNV-OS-H101 Sec.4 G300.

2.2.4.4 During the transports, daily reports shall be submitted to the MWS, and other relevant parties.

2.3 Operational aspects

2.3.1 General

2.3.1.1 The general requirements for planning and executing the operation stipulated in DNV-OS-H101 Sec.4 apply.

Guidance note:
The following sub-sections include some additional requirements and/or emphasis on requirements considered generally important for transport operations. More detailed operational requirements for each type of sea transport are included in Sec.4, Sec.6 and Sec.7.

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2.3.1.2 The operational risk shall be evaluated and handled in a systematic way. See DNV-OS-H101 Sec.2 C. The sea transport shall be carried out with due consideration to identified risks and prescribed risk mitigations.

2.3.1.3 The sailing route shall be carefully selected considering the predominant weather directions and possibility of extreme weather conditions and other risks related to e.g. collision, grounding and piracy.

2.3.1.4 The Master shall engage local pilotage assistance during the towage or voyage, as appropriate.

2.3.2 Weather conditions

2.3.2.1 The operation manual shall clearly define weather limitations and weather forecast requirements.

2.3.2.2 Environmental conditions such as fog, current and tide could be of significant importance to transport operations and shall be duly considered.

2.3.3 Operational restrictions

2.3.3.1 The operation shall be planned with due consideration to any restrictions imposed by the design assumptions and/or requirements in the standard. Operational restrictions may be due to:

— weather conditions, see [2.3.2]
— heading control, see [2.1.5]
— air draught, see [2.3.5]
— particulars of sailing routes and sea room, see [4.4.4]
— clearances, see [4.4.6].

2.3.3.2 Weather restricted transports shall be carried out within an appropriate weather window or they shall be weather routed as staged transports.

Guidance note:
A staged transport is a tow or transportation in which there is a commitment to seek shelter (or jack up at a standby location) on receipt of a bad weather forecast. This relies on there being sufficient suitable ports (or sheltered standby locations) along the route. It can proceed in stages between shelter points, not leaving or passing each shelter point unless there is a suitable weather forecast for the next stage.

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2.3.4 Ports of shelter

2.3.4.1 Before departure, ports of shelter, or sheltered holding areas on or adjacent to the route, with available safe berths, mooring or holding areas, shall be agreed and all necessary permissions obtained.

2.3.4.2 Where such shelter points are required as part of a weather restricted operation, as described in [6.3], it shall be possible to enter them safely in worsening weather.

2.3.5 Air draught

2.3.5.1 When passing under bridges and power cables, the overhead clearance shall be calculated allowing a margin of not less than 1.0m after accounting for the applicable effects in the Guidance note to [4.4.6.5].

Guidance note 1:
Immediately before the passage, the tidal level should, if critical, be confirmed by measurement.

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Guidance note 2:
Power cables need a “spark gap” as well as a physical clearance; the transmission company will have its own criteria for the minimum allowable clearance. It should also be noted that the catenary of the power cable will change depending on the load being carried in the cable; the lowest position should be used.

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2.3.5.2 The minimum margin on the overhead clearance should be available in the entire width of the sailing route.

2.3.5.3 Where clearance is limited, then a dimensional survey of the barge/vessel and structure shall take place just prior to sail away in order to ensure that the required clearance exists.

2.3.5.4 The actual clearance shall be confirmed with all the appropriate authorities, including those responsible for the obstruction.

2.3.6 Organisation and personnel

2.3.6.1 General requirements relating to the organization, personnel qualifications and communication are given in DNV-OS-H101 Sec.4 E.

2.3.6.2 The organization chart (and/or description) shall clearly indicate the person responsible for briefing the tug/ship Master. This is to ensure that he has received all the necessary documentation for the voyage (see [2.2.4]) and is well aware of any operational restrictions (see [2.3.3]).

2.3.7 Inspections and testing

2.3.7.1 It shall be ensured by inspections and testing that all equipment, systems and vessels are in an adequate condition. See DNV-OS-H101 Sec.4 F.

2.3.7.2 The erection, testing and removal of seafastening shall be included in the operational planning, see [3.5].

2.4 River and sheltered area transports

2.4.1 Application

2.4.1.1 River transports refer to transports of components using inland vessels or barges on inland waterways (e.g. rivers, canals, lakes).

2.4.1.2 Sheltered area transports refer to transports using ships or barges in coastal areas where the maximum motions due to wind-generated waves are small.

Guidance note:

Generally, the transports should be carried out in an area with very limited (i.e. no swell and $H_s \leq 1.0$ m) waves. The use of weather routing may be considered to ensure this.

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2.4.2 General

2.4.2.1 All operations and process steps during the transport have to meet national regulations.

2.4.2.2 All requirements given in this Standard for the planning and execution of sea transports are generally applicable to river and sheltered transports. Due attention shall especially be paid to:

— traffic restrictions
— sailing restrictions (e.g. due to the air draught, channel depth and width, daylight requirement)
— river/canal and tidal current
— water level
— risk of collision and/or grounding
— waves created by other vessels.

2.4.2.3 The transport vessel and/or the towing configuration shall be suitable and have a crew familiar with the sailing area/route.

2.4.3 Seafastening

2.4.3.1 The seafastening design shall fulfil the general seafastening design requirements given in [3.5].

2.4.3.2 Seafastening design loads shall be based on the environmental characteristics of the actual voyage, in addition to loads imposed by the elements given in Sec.2.4.2. It has to be proven that components and vessels could withstand the dynamic forces to be expected during inshore transport.

Guidance note:

Normally, the seafastening required for harbour moves (see [3.5.1.2] referencing to DNV-OS-H201 Sec.3 F400) could be considered adequate. Seafastening for sea transports that may encounter waves higher than $H_s = 0.5$ m should in addition be verified for forces based on calculated accelerations.

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2.4.3.3 The effect on the seafastening of unintended impact loads shall be considered. Hence, the seafastening should normally be able to fulfil its intention after being deformed by an overload and/or adequate additional securing by friction effects should be documented. See [2.4.3.4] below.

2.4.3.4 Friction may be allowed to contribute under the condition that the entire load path, including the potential sliding surfaces, shall be demonstrated to be capable of withstanding the loading generated. The maximum horizontal displacement of the cargo due to a possible collision with a quay, ground or nearby vessels (in areas of high marine traffic density) shall be assessed and the vertical supports (grillage) shall be verified (in ALS) for the re-positioned cargo.

SECTION 3 DESIGN REQUIREMENTS

3.1 General

3.1.1 Design basis and principles

3.1.1.1 The agreed design basis and design brief shall form the basis for the design calculations. See DNV-OS-H101 Sec.2 A600.

3.1.1.2 The general design principles to be followed are described in DNV-OS-H102 Sec.2

3.1.2 Environmental conditions

3.1.2.1 All possible environmental conditions, see DNV-OS-H101 Sec.3, shall be evaluated and considered in the design.

3.1.3 Strength calculations

3.1.3.1 All load-carrying elements without a certified capacity shall be verified by calculations. Typical elements requiring separate verification are:

— strength aspects for towed objects, vessels and cargo not covered by certification /Class
— grillage elements
— seafastening elements.

3.1.3.2 Structural strength calculations for transported cargo and grillage/seafastening shall be performed covering wave directions at least every 45 degrees. Computed inertia loads at each wave direction shall cover all six degrees of freedom (DoF). Phase differences between DoFs may be taken into account.

Guidance note:
It may be found adequate to include only the beam and head sea in the ULS checks, especially if using standard motion criteria. See the guidance notes in [3.2.3.5] and [6.2.2.6].

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3.1.3.3 The global bending/torsion of the transportation barge/vessel shall be included if the cargo’s support condition may induce significant deformation loads. See also [3.3.2.2] (and [3.5.3]).

3.1.3.4 It shall be ensured that the gravity component of the roll and pitch motion has been added to the horizontal (design) accelerations in Cargo CoG.

Guidance note:
The gravity component has been added in the standard criteria in [3.2.3] and [6.2.2.3], but may have been omitted in the output from (some) motion response analysis.

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3.1.3.5 The increased horizontal load due to wind loads and wind induced trim/heel shall be investigated and included when relevant.

3.1.3.6 Computed motion response transfer functions shall cover a sufficient number of wave periods to accurately capture the response peaks. Furthermore, the wave period range shall be wide enough with respect to the energy in the combined wave spectra.

Guidance note:
A wave period range from 0.5*Tz,min to 2.0*Tz,max is usually sufficient. Tz,min and Tz,max are the minimum and maximum Tz defining the applicable period range, see DNV-OS-H101 Sec.3 C800.

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3.1.3.7 Global and local conditions with respect to corrosion shall be considered in the design calculations. See DNV-OS-H102 Sec.2 B500.

3.1.4 Certified properties

3.1.4.1 Element properties (e.g. strength, capacities, dimensions, weight, etc) may be verified by having certified properties. The conditions for the certification (or classification) shall be stated. Elements that may be subject to this verification procedure are:

— vessel global strength covered by class
— towing brackets
— towing equipment

— mooring equipment
— winches and foundations.

3.1.4.2 Modifications to or the use of certified equipment and classed vessels outside specified limitations, require acceptance by the certifying/classifying body. Typical examples are:

— exceeding allowable global bending moments in restricted waters
— ballasting of the vessel to a draft below the load line
— significant vessel reinforcements.

3.1.5 Stability afloat

3.1.5.1 The stability and watertight integrity shall fulfil the applicable requirements stated in DNV-OS-H101 Sec.5.

3.2 Motions and accelerations

3.2.1 General

3.2.1.1 The determination of motions shall comply with DNV-OS-H102 Sec.4 B.

3.2.1.2 In general, it is advised to perform motion response calculations based upon a 3D panel model of the transportation vessel. If a 2D strip theory model is used, the computer program needs to include the proper treatment of head/stern sea wave excitation loads.

3.2.1.3 Simplified calculations should only be applied for non-critical routine operations or screening purposes.

Guidance note 1:

— For single barge towing, simplified criteria according to [3.2.3] may be used.
— For ship transports, simplified criteria according to IMO or DNV Ship Rules may be applied, see [6.2.2].

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Guidance note 2:
If the “Noble Denton Standard Criteria” that are included in 0030/ND are used, the following should be considered:

— No reduction in seafastening forces due to friction is allowed using these criteria.
— These criteria are based on a safety format differing from the VMO Standard.

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3.2.2 Wind heeling and heave-induced roll

3.2.2.1 For vessels with a low GM value, special consideration should be given to the effects of wind heeling.

3.2.2.2 Heave-induced roll motions may occur if there are large changes in the water-plane area with the draught. In such a situation, a special analysis and/or model tests should be performed to quantify this effect.

3.2.3 Simplified motion criteria for barges

3.2.3.1 Assuming the indicated conditions the accelerations given in Table 3-1, Table 3-2 and Table 3-3 could normally be applied to a standard “North Sea Barge” (300’ × 90’ × 20’) and bigger barges. Table 3-1 could normally also be applied to smaller barges, but see [3.2.3.3].

3.2.3.2 For barges smaller than a “North Sea Barge”, Table 3-2 and Table 3-3 could be assumed to be valid if the limiting wave heights (6 m and 4 m) are reduced by multiplying by the following factor:

— Minimum of L/L_{NSB} and B/B_{NSB}), where:
— L is the length of the barge
— L_{NSB} is 300’ (91.4 m)
— B is the breadth of the barge
— B_{NSB} is 90’ (27.4 m)

Guidance note:
Alternatively, the limiting wave heights (6 m and 4 m) can be used, if the accelerations from Table 3-2 and Table 3-3 are multiplied by $\max\{L_{NSB}/L, B_{NSB}/B\}$,

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3.2.3.3 The simplified motion criteria may be considered to give accelerations on the safe side for all barges with B > 20 m and L > 50 m. However, for transports that are very sensitive to the acceleration level, it is recommended to carry out analysis and/or model testing in order to verify the results and also to avoid unnecessary work/costs.

3.2.3.4 Table 3-1 indicates the acceptable characteristic beam sea (roll case), quartering and head sea (pitch case) accelerations for unrestricted world-wide barge transports.

3.2.3.5 All three (3) cases in the tables should be considered. In each case, all possible combinations of directions of the indicated ax, ay and az accelerations shall be taken into account. Wind force should be added.

Guidance note:

It may be found acceptable to omit the quartering case based on engineering judgement. At least the seafastening forces and maximum vertical support reaction should be evaluated.

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Table 3-1 Unrestricted criteria world wide

Acceleration/wind force	*Roll Case*	*Quartering*	*Pitch Case*
ay at waterline	0.50 g	0.40 g	0
ay increase for each metre (z) above waterline	0.017 g/m	0.013 g/m	0
ax at waterline (wl)	0	0.15 g	0.25 g
ax incr. each metre (z) above waterline	0	0.005 g/m	0.007 g/m
az at centre (C) barge	0.20 g	0.15 g	0.10 g
az incr. each metre (y, d or x respectively) from C	0.017 g/m	0.012 g/m	0.007 g/m
Wind pressure	1.0 kN/m2	1.0 kN/m2	1.0 kN/m2

Notes:

- see [3.2.3.1], [3.2.3.2] and [3.2.3.3] for limitations and assumptions
- x = distance from vessel/barge mid ship
- y = distance from vessel/barge centreline
- d = distance used for calculating az in quartering sea, $d = (y^2 + 0.5 * x^2)^{0.5}$
- z = height above waterline.
- **ay** = transverse acceleration parallel with barge deck
- **ax** = longitudinal acceleration parallel with barge deck
- **az** = acceleration normal to the barge deck.
- the accelerations include the component for self-weight
- see DNV-OS-H102 Sec.4 C300 for load combinations of accelerations and wind force
- if the effect of rotational inertia is negligible, ax, ay and az may be calculated in the cog of the cargo. If not, they should be calculated at carefully selected “mass locations” on the cargo, in order to include the effect of rotation.

3.2.3.6 Table 3-2 indicates acceptable characteristic accelerations for unrestricted barge transports in areas/ seasons with a design wave Hs ≤ 6 m or for weather restricted transports with $OP_{LIM} \leq 6$ m. See Table 3-1 for details/notes.

Table 3-2 Criteria for Hs ≤ 6 m

Acceleration/wind force	*Roll Case*	*Quartering*	*Pitch Case*
ay at waterline	0.37 g	0.28 g	0
ay increase for each metre (z) above waterline	0.017 g/m	0.013 g/m	0
ax at waterline (wl)	0	0.12 g	0.17 g
ax incr. each metre (z) above waterline	0	0.004 g/m	0.006 g/m
az at centre (C) barge	0.20 g	0.15 g	0.10 g
az incr. each metre (y, d or x respectively) from C	0.017 g/m	0.011 g/m	0.006 g/m
Wind pressure	0.5 kN/m2	0.5 kN/m2	0.5 kN/m2

Notes: See notes to Table 3-1.

Guidance note:

The above criteria may normally be considered applicable for unrestricted towing during the summer (June-July-August) in the North Sea.

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3.2.3.7 Table 3-2 indicates acceptable characteristic accelerations for unrestricted barge transports in areas/ seasons with a design wave Hs ≤ 4 m or for weather restricted transports with OP_{LIM} ≤ 4 m. See Table 3-1 for details/notes.

Table 3-3 Criteria for Hs ≤ 4 m

Acceleration/wind force	*Roll Case*	*Quartering*	*Pitch Case*
ay at waterline	0.26 g	0.20 g	0
ay increase for each metre (z) above waterline	0.017 g/m	0.013 g/m	0
ax at waterline (wl)	0	0.08 g	0.12 g
ax incr. each metre (z) above waterline	0	0.003 g/m	0.004 g/m
az at centre (C) barge	0.15 g	0.12 g	0.08 g
az incr. each metre (y, d or x respectively) from C	0.017 g/m	0.009 g/m	0.004 g/m
Wind pressure	0.3 kN/m2	0.3 kN/m2	0.3 kN/m2

Notes: See notes to Table 3-1.

Guidance note:
The above criteria may normally be considered applicable for restricted towing along the Norwegian coast. It may also be found applicable for restricted towing from the Norwegian coast to NCS offshore fields.

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3.2.3.8 If accelerations corresponding to an OP_{LIM} are used, an appropriate OP_{WF} shall be defined duly considering the planned tow duration and procedure. See [2.1.2] and DNV-OS-H101.

3.3 Loads and load effects

3.3.1 General

3.3.1.1 Characteristic loads shall be defined according to DNV-OS-H102 Sec.3.

3.3.1.2 It shall be thoroughly evaluated if any other loads not described in DNV-OS-H102 need to be considered.

3.3.1.3 Load analysis shall be carried out according to DNV-OS-H102 Sec.4 A.

3.3.2 Vessel motions and deflections

3.3.2.1 Characteristic loads due to vessel motions and accelerations shall be calculated based on [3.2] as applicable for the considered transport.

3.3.2.2 Loads caused by vessel hull beam deflections shall be considered. See DNV-OS-H102 Sec.4 A800 and [3.5] regarding loads in seafastening.

3.3.2.3 Any restrictions in the internal design of the towed/transported object, e.g. w.r.t the internal flexibility of piping, shall be investigated and accounted for in the operation planning and design.

Guidance note:
On towed objects such as FPSOs, which may have permanently installed modules with piping or other connections between them, there should be adequate flexibility in the connections to avoid overstress. It should be noted that the transport wave bending condition may be more severe than the operating condition. In long modules carried as cargo, the internal pipework should be similarly considered.

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3.3.3 Cargo overhangs, buoyancy and wave slam /green water

3.3.3.1 Slamming load and green water requirements are given in DNV-OS-H102 Sec.3 D300 and D400.

3.3.3.2 The exposed parts of a barge transported jacket, particularly those overhanging or close to the bow of the barge (including buoyancy tanks, pile sleeves and mud mats) shall be designed to withstand wave impact loads.

3.3.3.3 Deck cargoes vulnerable to excessive loads from “green water” on deck may need to be protected by breakwaters or increasing the freeboard.

3.3.3.4 Buoyant cargoes, particularly where the buoyancy contributes to vessel/barge stability, shall be adequately secured against lift-off unless it can be shown that lift-off will not occur.

3.3.3.5 The effect of waves and the vessel speed shall be included in the seafastening design loads when calculating forces on immersed parts of transported objects.

3.3.4 Load cases

3.3.4.1 Load cases for transport operations shall be defined according to DNV-OS-H102 Sec.4 C.

3.3.4.2 The sea transport should be represented by a sequence of load cases determined by environmental loads, wave headings, self-weight, relevant accidental loads and combinations of these.

3.3.4.3 The most critical load cases considering each specific member of the object shall be identified.

3.3.4.4 Critical load cases may be analysed as quasi-static load cases, adding loads due to dynamic motions of the vessel to the static loads caused by the self-weight of the object. If relevant, skew loads, see e.g. [5.3.6], should be considered.

3.4 Fatigue calculations

3.4.1 General

3.4.1.1 Fatigue damage during transportation shall be assessed, see DNV-OS-H102 Sec.5 C101.

3.4.1.2 Design factors shall be defined according to DNV-OS-H102 Sec.5 C200.

3.4.2 Fatigue limit state design considerations

3.4.2.1 Typical loads/effects that could contribute to fatigue damage and shall be considered are:

a) Wave-induced inertia loads on cargo, including grillage and seafastening.
b) Vortex-induced vibrations (VIV) due to wind loads on long slender elements.
c) Wave loads on self-floating objects.
d) Deformation loads on cargo due to the wave-induced bending and torsion of transportation vessel.
e) Slamming loads on vessels and/or overhanging cargo.
f) Increased loading and number of cycles due to swinging/vibrating members, e.g. caused by slamming loads on the transport vessel.

3.4.2.2 The FLS design waves (and wind) shall be carefully selected based on a “worst case scenario” regarding weather conditions during the transport.

Guidance note:
For calculating the maximum expected transport fatigue damage, it is recommend to select weather conditions that do not have more than a 10% probability of being exceeded with regard to cumulative fatigue damage.

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3.4.2.3 A reasonable conservative exposure time for FLS calculations shall be selected for calculating the maximum expected transport fatigue damage.

Guidance note:
The following exposure times should normally be considered:

— For transports from one sheltered location to another: $1.5 \times T_{POP}$
— For transports to an offshore (wave exposed) location ample time should be added to account for the maximum expected waiting time including possible return(s) to the inshore holding location.

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3.4.2.4 Fatigue damage shall be calculated for representative sea-vessel relative directions. The spacing between analysed wave headings should not exceed 45°. Symmetry may be considered.

3.4.2.5 The most probable (percentage) exposure time in each sea-vessel relative direction should (could normally) be selected for calculating the maximum expected transport fatigue damage.

Guidance note:

For transports with sailing routes for which no predominant sea-vessel directions can be expected, the exposure time and analysed directions may be selected according to the table below. If applicable, symmetry may be considered to reduce the number of load cases/directions.

Sea direction	Head	H, Q-Port	Beam-Port	T, Q-Port	Tailing	T, Q-Stb.	Beam-Stb.	H, Q-Stb.
Representing range	337.5-22.5	22.5-67.5	67.5-112.5	112.5-157.5	157.5-202.5	202.5-247.5	247.5-292.5	292.5-337.5
Analysed direction	0	45	90	135	180	225	270	315
Exposure in %	10	15	15	10	10	10	15	15

H and T denote head seas and tail seas, respectively. Q denotes quartering (45 deg.) seas.

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3.4.3 Calculation methods

3.4.3.1 Simplified FLS checks of objects exposed to wave induced inertia loads can be performed based on the computed ULS stresses, assuming a conservative stress range distribution, see [3.4.2.2].

Guidance note 1:

An adequately conservative stress range distribution may be obtained by a two-parameter Weibull distribution (see DNVGL-RP-0005 [5.1]) where a Weibull shape parameter h = 2.0 is applied. Use of a lower shape parameter should be justified.

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Guidance note 2:

If control of the fatigue damage during transport is required, it is recommended to base the fatigue calculations on representative wave height/period blocks with a defined exposure time in each block.

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3.4.3.2 For FLS analysis based upon transfer functions for stresses combined with wave spectra and voyage scatter diagrams, the following should be considered:

a) The applied viscous roll damping shall correspond to typical fatigue waves, or be given for individual cells in the scatter diagram.

b) Voyage scatter diagrams used to find the maximum transport fatigue shall be selected as indicated in [3.4.2.2].

3.4.3.3 For heading control transports (see [2.1.5]), directional scatter diagrams used in transportation fatigue calculations may be truncated so that no sea states higher than the reduced design sea states occur for the beam sea and quartering sea conditions.

Guidance note:

In FLS calculations, heading control may be applied/assumed based on a risk evaluation, including for vessels that do not fulfil (all) the requirements in [2.1.5.3] and [2.1.5.4]. Possible increased exposure time should be considered, see [2.1.5.5].

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3.4.3.4 A long-term scatter diagram for the voyage will give the expected mean value of the accumulated fatigue damage. This could with care be used to evaluate the probable damage to be added to in-place fatigue, but this approach should normally not be used if the transport fatigue damage alone may be critical.

Guidance note:

If the above approach is used, it is necessary to maintain control of the fatigue damage, see [3.4.4.1], and mitigating actions [3.4.4.2]) to avoid exceeding the applied fatigue stress range should be in place.

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3.4.3.5 FLS calculations need to be based on the actual (linear elastic) stress (range) distribution. Hence, the effect of friction and restraint forces (vessel deflection) on the stresses shall be adequately calculated. See [3.5.2.9].

3.4.4 Fatigue control

3.4.4.1 For fatigue critical transports, it is recommended to maintain control of the (anticipated) fatigue damage during the transport. This is especially important if the assumed stress range distribution could be non-conservative.

Guidance note:

Fatigue damage could be controlled by regular inspections and/or by verifying that the actual fatigue stress range is less critical than the stress range applied in the calculations. The stress range could be controlled by setting up systems that compare the actual to the applied:

— exposure time
— wave scatter diagram considering relative vessel/sea directions
— vessel motions, e.g. calculated vs MRU readings
— member loads/stresses.

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3.4.4.2 Whenever relevant, mitigation actions to avoid excessive transport fatigue shall be defined.

Guidance note:

Mitigation actions could be heading control and/or weather routing. Regular inspections combined with repair possibilities could/should also be considered.

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3.5 Grillage and seafastening

3.5.1 Application

3.5.1.1 The transported object is normally supported and secured to the vessel by seafastening and grillage elements. This sub-section includes general requirements for such securing systems.

Guidance note:

Welded steel seafastening is preferred, but for smaller cargo units (typically of less than 100 tonnes) chain, wire rope or webbing lashings with suitable tensioning devices may be acceptable. Wire rope or webbing (fibre rope) lashing is not recommended for unmanned transports, see [6.2.4.6].

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3.5.1.2 For minimum seafastening and grillage for harbour moves, see DNV-OS-H201 Sec.3 F400 and [2.4].

3.5.1.3 For seafastening by lashing, see additional requirements in [6.2.4].

3.5.1.4 For special considerations regarding wood cribbing, see [7.3.6].

3.5.2 Design principles

3.5.2.1 The grillage elements, including shimming plates, shall be used to distribute a concentrated deck load to a sufficient number of load-carrying elements.

3.5.2.2 Seafastening shall be used to secure the transported object from rotations (e.g. overturning) and translations in all directions.

3.5.2.3 The seafastening and grillage design shall duly reflect the structural strength limitations of both the object and transport vessel.

Guidance note:

The effect of global loads on local strength should be considered. E.g. a buckling check of vessel-stiffened panels for support loads from cargo should include the stresses caused by hull bending moments and shear forces.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.2.4 Grillage and seafastening shall be designed (and erected) taking into account all the physical limitations implied by the load transfer procedures/methods both to and from the transport vessel(s).

Guidance note:

Typical physical limitations could be related to:

— available heights
— strict tolerances, etc. imposing requirements for the erection/welding sequence, see also [3.5.2.9]
— loadout trailer layout
— needed space for (operation of) loadout systems, e.g. pumps, hoses, pull/push units
— set down tolerances and shimming requirements
— cutting/handling offshore
— securing of object before lift, see [3.5.2.6]

— possible need to set down the object again and re-instate seafastening offshore, see [3.5.2.10] and [3.5.2.11].

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3.5.2.5 The design calculations shall include any positioning tolerances for the transported object on the grillage, including, if applicable, the effect of vessel hull beam deflections.

Guidance note:

Positioning tolerances should be included in the load-out procedure, see DNV-OS-H201 Sec.3 F400.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.2.6 The seafastening design for offshore or inshore installation operations shall allow for easy release and provide adequate support and horizontal restraints until the object can be lifted clear of the vessel, or launched as applicable.

Guidance note:

A procedure is required, see [3.5.11].

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3.5.2.7 Elements providing horizontal and/or vertical support after the cutting/removal of the seafastening shall be verified for the forces caused by the characteristic environmental conditions applicable for the installation operation.

3.5.2.8 Wave entry (slamming) and exit loads must be considered for overhang cargo in the seafastening design. See also [7.3.6.8].

3.5.2.9 Vessel global deflection due to both waves and the redistribution of ballast may impose significant loads on grillage elements and seafastening. Both additional horizontal and vertical loads shall be considered, see [3.5.3.7] and [3.5.3.9]. See also [3.3.2].

Guidance note:

In order to reduce the effects as much as possible, it is recommended to carry out seafastening welding with the vessel ballasted to the transportation condition, or mimic this condition as close as draught limitations permit. Set down that includes shimming at the supports should also be carried out with the transport vessel in a condition that at least mimics the transport condition.

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3.5.2.10 For special seafastening precautions after back loading offshore, see DNV-RP-H102.

3.5.2.11 If the reinstatement of the transport seafastening may be required offshore, this should be taken into account in the design and the cutting/release procedure.

3.5.3 Design calculations

3.5.3.1 The grillage and seafastening strength shall be verified according to DNV-OS-H102 sections 5 and 6 for applicable load cases defined according to [3.3].

3.5.3.2 The (assumed) force distribution in the seafastening and grillage shall correspond to the reaction forces considered in verifications of the strength of the vessel and transported object.

3.5.3.3 Possible uplift due to the overturning of the object and/or relative deflections shall be prevented by seafastening whenever required. See also [3.5.3.10].

Guidance note:

Uplift seafastening is always required if the object overturning moment is greater than the object restoring moment in the “worst” applicable ULS load combination. Also, if the “first uplift” represents an ULS, an additional safety factor corresponding to a “material factor” should be applied. This could be done by applying a load factor of 0.85 on G loads in the uplift load case(s). The need for prohibiting calculated “local” uplift should be evaluated in each case. If not prohibited the effect of “gaps” and the redistribution of reaction loads should be taken into account.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.3.4 Friction forces on the cargo supports may be considered as part of the seafastening. This is conditional until the applied friction effects have been properly documented, see DNV-OS-H102, Sec.4 A600, and a minimum seafastening has been installed, see [7.3.5.4] generally and [3.5.1.2] for harbour moves.

Guidance note:

The following maximum design friction coefficients for calculating of favourable friction forces may/should normally be considered:

— Steel to steel, wet: 0.0.
— Steel to steel (wet and dry) if vibrations (see [3.5.4.2]) may occur: 0.0.

— Steel to steel dry: 0.1.
— Steel to wet timber: 0.2.
— Steel to dry timber or rubber (wet or dry): 0.3.
— Timber to timber: 0.4.

It is assumed that the friction surfaces are free from oil or other lubricating fluids.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.3.5 Any uncertainty about the in load distribution between (seafastening) members and friction forces shall be taken properly into account.

Guidance note:

The force/load distribution between friction supports and seafastening may be calculated (assessed) by comparing the deflection needed to mobilize friction with seafastening stiffness. If this is not done, the following precautions should be implemented:

— Seafastening members should be designed to tolerate possible "overloading", see [3.5.3.7].
— In FLS, friction should not be used to reduce the seafastening loads in any sea state up to that which results in a seafastening load without friction equal to the ULS characteristic load with friction.

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3.5.3.6 Restraint loads due to vessel deflections and inertia loads may be combined as given in DNV-OS-H102 Sec.4 C400.

Guidance note:

The global moments to be taken into account when calculating global deflections do not need to be greater than the wave bending moments calculated according to DNV Ship Rules.

For barges, the hogging and sagging moments could be calculated by quasi static methods taking into consideration the varying buoyancy force for a wave of length L_w equal to the barge length and height of 0.61 $L_w^{0.5}$ metres.

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3.5.3.7 The magnitude of restraint loads, especially if caused (entirely or partly) by friction effects, could be difficult to calculate accurately. Hence, the following precautions should be taken:

— Avoid if possible designs/layouts that cause restraint forces.
— Minimize restraint forces as a result of ballasting to transport condition, see Guidance note to [3.5.2.9].
— The end connection of seafastening elements with significant restraint forces should be made stronger than the element itself.
— A thorough evaluation of the "worst case distribution" of restraint forces between seafastening elements should be carried out. Reasonably conservative assumptions regarding force distributions should be considered in FLS calculations. See [3.4.2.1] d).

3.5.3.8 Horizontal restraint loads that may occur for statically undetermined seafastening arrangements shall be considered.

Guidance note 1:

Horizontal restraints may typically occur for longitudinal (pitch) seafastening arrangements with fixed stoppers at both object ends. It is generally recommended to avoid, as far as possible, horizontal restraint loads by having a well-designed seafastening lay-out. It is normally recommended to position pitch stoppers at only one transverse cross-section along the cargo, preferable as close as practical to the CoG of the cargo.

Restraint loads may normally be ignored for transverse (roll) stopper arrangements if the stoppers are arranged on both sides of the module and each stopper supports load in one direction only. If the stoppers support loads in both directions, the effect of restraints (due to torsional vessel deflection and bending about longitudinal and vertical axes) should be considered.

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Guidance note 2:

In order to obtain a statically determined system, seafastening and grillages are sometimes arranged with sliding surfaces. If sliding surfaces are used, any effects caused by the sliding should be considered, i.e. possible clashes, fixation of "low-friction" pads, etc.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.3.9 Restraint loads caused by relative vertical displacements of supports due to vessel hull beam bending and vessel torsion deflection shall be taken into account.

Guidance note 1:

Vertical restraint effects should normally be considered for vessel transports of objects with three pairs/rows or more of supports in the vessel's longitudinal direction.

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Guidance note 2:

For objects supported on four (or more) supports, it may be required to consider restraint effects due to torsion deflection of the hull beam. The following guidance applies:

— The torsional moment may be calculated according the DNV Ship Rules Pt.3 Ch.1 Sec.5 B206.
— Torsional deflection does not normally need to be taken into account for objects on ships without large deck openings (i.e. a total width of hatch openings in one transverse section exceeding 65%). Nevertheless, for torsion stiff objects with a greater area between outer supports than $5 \times B^2$ (vessel breadth), it is recommended to consider the effect of hull beam torsion for all types of vessels.

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3.5.3.10 Vertical restraint loads that may typically occur in tension details (uplift stoppers, connections to barge decks) should be especially considered.

3.5.4 Fatigue and vibrations

3.5.4.1 Seafastening should be designed taking fatigue into consideration, see [3.4].

3.5.4.2 The effect of vibrations due to wave entry (slamming) loads on the vessel hull and/or on overhanging cargo shall be assessed. Typical effects could be:

— Reduction of "efficient" friction, see [3.5.3.4].
— Seafastening is needed to prevent swinging/vibration of slender members/equipment/pipes.
— Unintended unscrewing of nuts/bolts.

3.5.5 Welded seafastening

3.5.5.1 General requirements for the fabrication of welded seafastening are given in DNV-OS-H102 Sec.6 B100 and B200.

3.5.5.2 Weld capacity should be calculated according to DNVGL-OS-C101 Ch.2 Sec.8. EN 1993-1-8 (Eurocode 3) may be used. Material factors according to [3.5.5.3] below shall be used, also if applying EN 1993-1-8.

Guidance note:

For check of vessel welds the following should be noted:

a) Class acceptance for these welds may be required, especially for new/reinforced welds.
b) All loads (force components) normal to the deck plate should generally be considered transferred to the under deck welds. However, with only compression force, i.e. no tension force in any load combination, this force component may be assumed to be transferred through direct contact between the deck plate and the web frames/ bulkheads, and the weld may be checked for shear stress only, see item f) below. If the force varies between compression and tension, the weld should be able to transfer also the compression force in order to ensure intact welds, unless the capacity of the seafastening system is documented in ALS with the considered connection assumed broken.
c) All loads (force components) parallel to the deck plate can be disregarded, see however item f) below.
d) The dispersion angle through the deck plate should be taken as maximum 45 degrees if a greater dispersion cannot be justified.
e) Size reduction due to possible corrosion should be considered. If not otherwise documented the size should be as shown on the drawing subtracted the Class corrosion allowance.
f) Note that shear stress in stiffener/girder welds due to local bending/shear in these needs to be included in the equivalent stress.

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3.5.5.3 It is recommended that design of seafastening field welds take into account a material factor to account for unfavourable deviations and larger uncertainty in the resistance of weld material from characteristic values. The following minimum material factors, γ_{Mw} apply:

— For welds made at fabrication site: $\gamma_{Mw} = 1.3$
— For welds made on board the transportation vessel: $\gamma_{Mw} = 1.5$

Guidance note:

If good welding conditions (see DNV-OS-H102 Sec.6 B200) and weld fit-up (e.g. control of correct/no gaps to deck plate) on board the vessel are ensured by procedures and well panned inspection γ_{Mw} = 1.3 may be found adequate.

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3.5.5.4 The distribution of forces in the seafastening welds should normally be calculated on the assumption of linear elastic behavior.

Guidance note 1:

Calculations based on plastic behaviour may be found acceptable, but this will require increase attention to, and possibly more detailed documentation of, FLS and uncertainties in load distribution in the seafastening. See also [3.5.5.6] and [3.5.5.7].

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

Residual stresses and stresses not participating in the transfer of load need not be included when checking the resistance of a weld. This applies specifically to the normal stress parallel to the axis of a weld.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.5.5 Welded connections shall be designed to have adequate deformation capacity.

3.5.5.6 In joints where plastic hinges may form, the welds shall be designed to provide at least the same design resistance as the weakest of the connected parts.

3.5.5.7 In other joints where deformation capacity for joint rotation is required due to the possibility of excessive straining, the welds require sufficient strength not to rupture before general yielding in the adjacent parent material.

3.5.5.8 Connections to the deck of a barge or vessel should be carefully considered. It should not be assumed, without inspection or drawings, that underdeck connections between deck plating and stiffeners or bulkheads are adequate. See also [3.5.10.3].

Guidance note:

Welds between vessel deck plates and under deck stiffeners/bulkheads are normally small and may limit the capacity.

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3.5.5.9 Any restrictions regarding welding to the object (or transport vessel) shall be taken into account.

3.5.6 Bolted seafastening

3.5.6.1 Bolted connections may be used in seafastening. The capacity of a bolt (group) connection shall be calculated based upon relevant recognized steel standard(s).

Guidance note:

See e.g. DNVGL-OS-C101 for relevant requirements and guidance. Additional practical guidance found in 0001/ND Appendix B should also be considered.

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3.5.6.2 Only slip-resistant bolt connections are allowed as seafastening.

3.5.6.3 Adequate material quality of the bolts shall be documented.

3.5.6.4 The bolts shall be installed and tensioned according to a documented procedure.

Guidance note:

Note that it could be difficult to ensure/document a proper procedure due to seafastening conditions/time restrictions.

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3.5.6.5 Proper arrangements/procedures for releasing bolted seafastening connections offshore shall be provided. See also [3.5.2.7].

3.5.7 Use of T-bars to support cargo and seafastening

3.5.7.1 The use of T-bars to support cargo is acceptable provided the T-bar scantlings and welding have been documented by Class (i.e. with respect to arrangement, material certification and scantlings) and properly surveyed.

Guidance note:

T-bars are T-shaped steel profiles welded onto the vessel deck in order to secure wooden deck boards. T-bars that have not been fully documented and surveyed by the classification society should be documented by calculations and a survey confirming the assumed design condition. Special attention should be paid to material quality and welding inspection (NDT) documentation for T-bars subject to tension and/or transverse loading. See also [3.5.7.2] below.

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3.5.7.2 Design considerations when using T-bars shall include:

— special attention to the material quality and condition if transferring uplift forces, see also [3.5.10.3]
— the limited ability to transfer any loads in the transverse direction of the T-bar
— the limited capacity of the T-bars unless they are directly aligned with the under-deck structure.

3.5.8 Securing of pipes

3.5.8.1 Generally, pipes should be secured during sea transport following the seafastening principles described in this sub-section ([3.5]). Adequate pipe seafastening will normally be obtained by following the guidance in 0030/ND, section 9.7.

3.5.9 Internal seafastening

3.5.9.1 All loose items shall be properly secured and/or stowed. Items that could be damaged by water shall be adequately protected.

3.5.9.2 Maximum possible accelerations/forces shall be taken into account.

Guidance note:

The internal seafastening requirement should reflect that the acceleration in the top of the transported object may be considerably higher than the CoG accelerations.

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3.5.9.3 The securing of internal items weighing more than 5 tonnes shall be verified by calculations.

3.5.9.4 It should be ensured that internal seafastening using lashing, clamping devices, etc, is adequately installed/tensioned to prevent the secured item from moving in any direction during the entire transport.

Guidance note:

See also as found applicable, section [6.2.4] for further guidance.

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3.5.9.5 Dunnage applied as seafastening (and load-spreading) shall be properly installed and secured.

3.5.10 Inspection of seafastening

3.5.10.1 All seafastening shall be inspected before departure to ensure that design assumptions are fulfilled and that proper workmanship has been used.

Guidance note:

Typical items that should be thoroughly inspected in addition to the design according to drawings/calculations could be:

— internal seafastening
— that all gaps are properly shimmed
— securing of (e.g. by tack welding) loose supporting elements (shim plates, wedges, woodblocks/dunnage, etc)
— lashings properly installed, see [6.2.4.6]
— bolted connections are properly tensioned and secured as specified by the designer.

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3.5.10.2 See DNV-OS-H102, Sec.6 B300, for seafastening weld inspection requirements.

3.5.10.3 Ultrasonic lamination testing of deck plating should be carried out if the imposed load results in the tensile stress normal to the plate exceeding 100 MPa, unless the steel is of Z quality. For single critical seafastening elements, it is recommended to carry out lamination testing even if the stress is below 100 MPa.

Guidance note:

Higher tensile stresses than 100 MPa caused by e.g. a local moment on seafastening brackets could be accepted in limited areas without lamination testing. The tensile stress should be calculated in a section between the deck plate and the weld (i.e. not in the critical weld section). If the under deck weld is smaller, this weld should be used as a reference, see also Guidance note to [3.5.5.8].

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3.5.11 Cutting/removal of seafastening

3.5.11.1 The cutting/removal of seafastening shall, if found applicable, be described in a procedure. A procedure shall be created if there are any restrictions on cutting/removal, see [3.5.2.6].

Guidance note:

The requirements stipulated in DNV-OS-H204 Sec.3 for the removal of jacket seafastenings may also be relevant for other objects and should be considered.

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3.5.11.2 It should be ensured that adequate equipment is available for seafastening removal according to plan.

3.5.11.3 Physical markings on the seafastening should be made to facilitate correct cutting.

3.6 Towing force calculations

3.6.1 General

3.6.1.1 The minimum required towline pulling force, F_{TR}, shall be calculated based on the towing route and procedures. The calculations shall, as applicable, document the required towing force for:

- Holding in open sea, see [3.6.2.1] (and [3.6.3.2]).
- Manoeuvring in narrow waters, see [3.6.2.2] (and [3.6.3.2]).
- Adequate speed, see [3.6.3.4].

3.6.1.2 The F_{TR} (towline pull required) calculations shall include the wind, wave-drift and current (i.e. relative speed between towed object and water) forces.

Guidance note:

Further guidance may be found in DNV-RP-H103, Sec.7.

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3.6.1.3 The F_{TR} should be calculated for all relevant combinations of wind, wave and current directions relative to the towed object.

Guidance note:

Allowances for the yaw (normally minimum +/- 30 degrees) of a single tug towed object should be made. See also [4.3.4] regarding multiple tug towing.

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3.6.1.4 The F_{TR} is calculated as an SLS loadcase, i.e. without load factors. Consequently, it is recommended that conservative assumptions are applied in the calculations.

3.6.1.5 The applied wind speeds shall include an adjustment for height, see DNV-OS-H101 Sec.3 B400.

3.6.2 Unrestricted towing

3.6.2.1 The F_{TR} for unrestricted open sea towing shall be calculated for the following conditions acting simultaneously:

- sustained wind velocity, V_w = 20 [m/s] (10 m above sea level)
- head current velocity, V_c = 0.5 [m/s]
- significant wave height, H_s = 5 [m].

Guidance note:

See [3.6.4.2] for towing in benign weather areas.

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3.6.2.2 The F_{TR} for unrestricted coastal towing and towing in narrow waters shall be calculated for the following conditions acting simultaneously:

- ten (10) minutes of sustained wind velocity with a 10-year return period (seasonal is normally acceptable, see DNV-OS-H101 Sec.3 A500)
- a one-year return period head current + 1 [m/s] vessel speed over ground
- a significant wave height according to DNV-OS-H101 Sec.3 C – unrestricted operations.

Guidance note 1:
Note that unrestricted towing in coastal and narrow areas with no wave sheltering is not accepted. See [4.4.2] and [4.4.4] for applicable requirements.

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Guidance note 2:
For towing of large objects by a towing fleet the additional current speed (1 m/s) representing the forward speed (i.e. additional safety) could normally be reduced to 0.5m/s.

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Guidance note 3:
The above criteria are based on the towing force being calculated as an SLS loadcase, see [3.6.1.4]. If the force calculation is based on less conservative conditions, ULS load factors should normally be applied.

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3.6.3 Weather restricted towing

3.6.3.1 See [2.1.3] for general weather restricted towing operations requirements.

3.6.3.2 For weather restricted open sea towing, the F_{TR} shall be assumed to be equal to the maximum towing force calculated according to [3.6.3.3] or [3.6.3.4].

3.6.3.3 In order to document that the tow will maintain forward speed under all possible weather conditions, the towing force shall be calculated for the following minimum conditions acting simultaneously:

— ten minutes of sustained wind velocity of 1.2 times the OP_{LIM} wind speed,
— a one year return period current + 0.5 [m/s], and
— the OP_{LIM} significant wave height, $OP_{LIM} < 5$ m.

3.6.3.4 In order to render probable that the tow can be carried out within T_{POP} the towing force shall be calculated for the following minimum conditions acting simultaneously:

— ten minutes of sustained wind velocity of the OP_{WF} wind speed,
— a one year return period current + the required forward speed (to obtain T_{POP}), and
— the OP_{WF} significant wave height.

Guidance note:
If the speed reduction due to current is considered moderate/insignificant and the towing speed in calm (i.e. Hs = 0 and $V_w = 0$) weather is documented, the towing speed may be estimated to be the calm weather speed multiplied by $F = 1 - (Hm/5)^2$. Hm = 80% of the OP_{WF} significant wave height.

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3.6.4 Special towing operations

3.6.4.1 For 24-hour moves of jack-ups, the following reduced criteria, acting simultaneously, may be used to calculate the F_{TR}:

— 3.0 metres significant seastate,
— 15 metres/second wind, and
— 0.5 metres/second current, or the maximum predicted surface current if greater.

3.6.4.2 For benign weather areas reduced criteria for calculating the F_{TR} may be found adequate based on the actual tow route and season. Generally, these should not be reduced below:

— 2.0 metres significant seastate, and
— 15 metres/second wind, and
— 0.5 metres/second current, or the maximum predicted surface current if greater.

SECTION 4 TOWING

4.1 General

4.1.1 Application

4.1.1.1 This section includes requirements for the towing arrangement, vessels, and operational aspects.

4.1.1.2 General requirements and design calculations for towing are covered in Sec.2 and Sec.3.

4.1.1.3 The requirements for various towed objects are given in Sec.5.

4.1.2 Complementary standards and guidance

4.1.2.1 For the towing of submerged objects, additional requirements and guidance are given in DNV-OS-H206 and DNV-RP-H103.

4.1.2.2 Reference is made to 0030/ND for special considerations regarding towage in ice-covered waters and the Caspian Sea.

4.2 Towing arrangement

4.2.1 General

4.2.1.1 The towing equipment and tug(s) shall be arranged so that proper control over the towed object is ensured.

4.2.1.2 A proper emergency towing arrangement independent of the main towing arrangement shall be provided. See [4.2.4]

4.2.1.3 Systems and equipment shall be designed, fabricated, installed, and tested according to DNV-OS-H101, Sec.6 A. Regarding testing, see also [4.4.9].

4.2.1.4 End connections of all wire ropes in the towing arrangements should preferably be spelter sockets. Pressed connections fitted with thimbles may be used. Spliced connections shall not be used.

4.2.1.5 End connections shall be in accordance with a recognised code and carried out by qualified personnel.

Guidance note:
EN 13411-4 is an applicable code for end socketing.

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4.2.1.6 The end link of towing chains shall preferably be a special enlarged link, but a normal link may be acceptable. An end link using a normal link with the stud removed is not acceptable.

4.2.1.7 All parts of the towing arrangement should/could normally be designed based on the required towline strength (F_{TD}, see [4.2.6]) for the towing vessel(s) as described in [4.2.7] through [4.2.11]. However, if failure of any part of the towing arrangement described in[4.2.8] through [4.2.11] is considered significantly more critical than a main towline failure, the strength calculation for that part should be based on the actual MBL of the towline.

Guidance note:
Increased criticality could be due to:

- The part needs also to be considered as part of the emergency towing arrangement.
- The failed part may hamper/delay any (part of) planned emergency towing.
- See [4.2.11.4].

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4.2.2 Towing configurations

4.2.2.1 This section covers towages with towing configurations as indicated in Table 4-1.

Table 4-1 Towing configurations

Tugs		*Objects*		*Tow called (see notes)*	*Comments (ref.)*
No.	*Position*	*No.*	*Position*		
1	NA	1	NA	Normal	
2 or more	Parallel	1	NA	Parallel	
2	Series	1	NA	Serial	See [4.2.2.2], [4.2.2.3]
3 or more	Series	1	NA		No
1	NA	2	Parallel	Double	See [4.2.2.2], [4.2.2.4]
1	NA	3 or more	Parallel		No
1	NA	2 or more	Series	Tandem	See [4.2.2.2], [4.2.2.5]

Notes – Definitions:

Normal tow: One tug towing one object.
Parallel tow: Two or more tugs in parallel. Each tug is connected by its own towline to the same towed object.
Double tow: Two towed objects each connected to the same tug with separate towlines. One of the towlines is of sufficient length to pass well below the first towed object.
Tandem tow: Two towed objects in series behind one tug, i.e. the second object is connected to the stern of the first object.
Serial tow: Two tugs in series. The towed object is connected to the second tug and this tug is connected to the leading tug.

4.2.2.2 Other towing configurations than normal and parallel may only be accepted based on a risk assessment of each case considering the actual tow arrangement, towed objects, route and season.

4.2.2.3 A *serial tow* may only be accepted if the lead tug is significantly smaller than the second tug. Also, the capacity of the second tug's towing arrangement must accommodate the combined bollard pull of the two tugs. More than two tugs in series are not accepted.

Guidance note:
The lead tug should have BP less than 50% of the second tug.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.2.4 A *double tow* may only be accepted for weather restricted tows with adequate operational precautions. The two towlines must be on separate winch drums and operated independently.

Guidance note:
Both towed objects should have an emergency towing arrangement as indicated in [4.2.4] and an operation procedure showing how to reconnect to one object while controlling the other object should be available.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.2.5 A *tandem tow* is not acceptable for ocean towing operations, and may only be accepted for weather restricted tows of short duration or in ice conditions where the towlines can be kept short to be clear of the water. More than two objects in series are normally not allowed.

4.2.3 Main towing arrangement

4.2.3.1 The main towing arrangement for a single tug towage should normally be from the forward end of the towed vessel (object) via a suitable bridle and connected to the tug’s towline by a triangular (‘delta’) plate. See [4.2.9].

4.2.3.2 Based on a proper risk assessment it may in some cases be found acceptable to tow the vessel (object) by the stern.

Guidance note:
The objects found beneficial for towing by stern could include:

a) Part-built or damaged ships or any structure where the bow sections could be vulnerable to wave damage.
b) Part-built ships, converted ships or FPSOs without a rudder or skeg, or with a turret or spider fitted forward, where better directional stability may be obtained if towed by the stern.
c) Any structure with overhanging or vulnerable equipment near the bow, that could be vulnerable to wave damage, or could interfere with the main and emergency towing arrangement.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.3.3 For other towing configurations, the main towing arrangement should be carefully planned considering the applicable requirements in [4.2.2].

Guidance note:

In a parallel tow configuration, each tug may normally be connected to the towed object with a single leg chain/wire rope pennant. If only two tugs are used, it is recommended to arrange bridles in the following cases:

— For the larger tug if there is a considerable difference in tug sizes.
— For both tugs if the towed object has a rectangular bow.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.4 Emergency towing arrangement

4.2.4.1 An emergency towing arrangement should be provided for all towed objects in any towing configuration.

Guidance note:

The emergency towing arrangement normally consists of a spare towing line on board the towing vessel(s) and pick-up arrangement connected to the towed object(s).

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.4.2 All parts of the emergency towing arrangement that may be used for towing shall fulfil the design load requirement (F_{TD}) in [4.2.6.1]. The pick-up arrangement, see [4.2.4.3] Guidance note items d) and e), should have an MBL ≥ 25 tonnes.

4.2.4.3 The emergency towing arrangement on the towed object shall be such that it can be connected to the towing vessel tow line in any weather condition that could be experienced along the tow route.

Guidance note:

The emergency system will for an unmanned tow typically consist of the following:

a) Towing connection point(s) with adequate strength (see [4.2.11] and if applicable [4.2.10]) and suitable position(s) (see [4.2.4.4]).
b) Closed fairlead(s).
c) Emergency pennant, minimum length 80 metres, with hard eyes or sockets, preferably in one length and lashed to the towed object side ensuring easy release. The length may be reduced for small barges and in benign weather areas.
d) Extension wire, if required, long enough to prevent the float line from chafing on the stern of the tow.
e) Float line, to extend 75-90 metres abaft the stern of the tow.
f) Conspicuous pick-up buoy, with reflective tape, on the end of the float line.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.4.4 The emergency towing arrangement shall be adequate to ensure safe and controllable towing without any increased towing force being required. Preferably, it should be fitted at the bow of the tow and connection point(s) should be independent from the main towline connection points.

4.2.5 Multi-barge transports

4.2.5.1 If two or more barges (vessels) are firmly connected through one large cargo item, the barges plus the cargo should be defined as one towed object.

4.2.5.2 Facilities such as barge deck winches, hydraulic jacks, thrust struts, etc., shall be considered in order to assist with the accurate positioning of the barges e.g. under construction pillars, during mating, etc.

Guidance note:

The simultaneous operation of winches and tugs should be carefully evaluated. Tugs and winches should preferably be used separately.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.6 Towing arrangement design load

4.2.6.1 Subject to the towline length(s) complying with [4.2.7.4] (or if applicable [4.2.7.5]), the design load (F_{TD}) for all components in the main and emergency towing arrangement shall for unrestricted towing be at least:

$F_{TD} = 3.0\ BP$	$BP \leq 40$
$F_{TD} = (220 - BP)\ BP/60$	$40 < BP < 100$
$F_{TD} = 2.0\ BP$	$BP \geq 100$

BP: Continuous static bollard pull of the vessel in tonnes.

Guidance note:

To apply a BP of less than the certified bollard pull of the vessel may be accepted provided a corresponding restriction on the bollard pull (i.e. towline tension) to be exercised by the tug is specified in the manual for the actual towing operation. Continuous monitoring of the towline tension from the tug's wheelhouse should then be possible and the maximum allowable pull should be 80% of the BP used for calculating F_{TD}. Normally, a towline tension overload alarm should be used/installed.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.6.2 For restricted and for special towing arrangements (e.g. if the towline(s) does not comply with [4.2.7]) the F_{TD} shall be based on a thorough evaluation of the:

— requirement in [4.2.6.1]
— towing configuration, see [4.2.2]
— length, operation and stiffness of the towline, see e.g. [4.4.5] (note especially [4.4.5.4] and [4.4.5.5])
— geographical area and tow route, see e.g. [4.1.2.2]
— season and possible weather restrictions
— number of tugs and tow spread lay-out
— characteristics of the towed object
— winch design
— available back-up/contingency.

However, the F_{TD} should normally not be less than 2 BP.

Guidance note:

For towing in benign weather areas, $F_{TD} = 2 \times BP$ is normally acceptable for all tug sizes if the towline length is adequate. For towing under some conditions, a higher FTD than indicated in [4.2.6.1] may be applicable, see e.g. [4.1.2.2], [4.4.5.4] and [4.4.5.5].

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.7 Towlines

4.2.7.1 Towlines for offshore towing should be steel wire ropes. For inshore (and weather routed coastal tows) tows, fibre ropes may be found acceptable.

4.2.7.2 The $MBL_{towline}$ for both main and spare towlines, as well as the emergency towline, shall be equal to or greater than the F_{TD} (see [4.2.6]).

4.2.7.3 The towline $MBL_{towline}$ shall be defined as the certified towline wire rope MBL reduced, if applicable, by the effect of bending and/or end connections.

Guidance note:

Normally, it is not required to reduce the towline MBL due to bending at the tug stern roller or to end termination by an adequately sized (certified) socket.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.7.4 The main and spare towing lines should for unrestricted towing have a deployable length of not less than:

$L_{towline} = 1800\ BP/F_{TD}$, but minimum 650 metres.

Where:

$L_{towline}$: Minimum deployable tow line length (m)
BP: Continuous static bollard pull of the vessel in tonnes
F_{TD}: Towline design load in tonnes, see [4.2.6.1].

Guidance note 1:

The deployable length should neither include the minimum remaining turns on the winch drum nor the distance from the drum to the stern rail or roller. One full-strength wire rope pennant which is permanently included in the towing configuration may be considered when determining the available length. In order to fulfil the above requirement, the towline total length normally needs to be at least 2000 BP / F_{TD}.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

Guidance note 2:

For coastal towages with a good weather forecast the minimum deployable length may be reduced to 500 m. If a fibre rope is used as a spare, a shorter line length than 500 m may be acceptable.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.7.5 For benign weather areas, the minimum main and spare towing lines' deployable length shall be not less than:

$L_{towline}$ = 1200 BP/F_{TD}, but minimum 500 metres.

4.2.8 Intermediate pennant and shackles

4.2.8.1 A pennant between the triangular plate and towing line is normally advisable to ease the connection work.

Guidance note:

A pennant with a lower minimum breaking load than the main towline may be applied if a reduction in the design requirements for the towline connections is desired. However, this is not a recommended approach.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.8.2 All wire rope pennants shall be of the same lay direction (i.e. right or left hand) as the towline.

4.2.8.3 The pennant MBL shall fulfil the F_{TD} requirement stipulated in [4.2.6].

Guidance note:

The considered pennant MBL should be the effective (reduced) MBL as defined in [4.2.7.3].

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.8.4 Fibre rope pennants should not be used where there is adequate depth and sea room to allow for sufficient shock absorbing in the tow line catenary.

4.2.8.5 If fibre rope pennants are used, they shall be in an as-new condition. The minimum breaking load of any fibre rope pennants shall not be less than 1.5 times the towline F_{TD}.

Guidance note:

Guidance Note:

IMO MSC/Circ.884 states: If fibre rope pennants are used, the pennants should be in a sound condition and the minimum breaking load of any fibre rope pennants should not be less than:

- 2.0 times the tow line MBL, for tugs with bollard pull less than 50 tonnes;
- 1.5 times the tow line MBL, for tugs with bollard pull greater than 100 tonnes; and
- linearly interpolated between 1.5 and 2.0 times the tow line MBL for tugs with bollard pull between 50 and 100 tonnes.

Fibre rope pennants should be of grommet construction and be terminated with hard eyes, and should not normally be connected directly to the apex of the towing bridle.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.8.6 Connection items such as shackles and rings shall have an MBL of not less than 1.3 times the towline F_{TD}. The shackle MBL shall be taken as the certified MBL reduced as applicable due to possible non-centric loading of the shackle.

Guidance note:

IMO MSC/Circ.884 states: All connecting items like shackles, rings, etc., should have an ultimate load bearing capacity of minimum 50% in excess of the documented minimum breaking load (MBL) of the towing arrangement to be used. It is recommended that this criteria is adhered to at least if the shackle MBL (i.e. the MBL/SWL factor) is not documented by any means other than a catalogue statement.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9 Towing bridle

4.2.9.1 A bridle should be used to connect the tow line to the towed object. Chains should be used in the way of chafing areas such as fairleads and deck edges.

Guidance note:

Locations where the bridle might bear on the towed object should be rounded off. In cases where the bridle consists of chain and wire, the length of the chain should extend beyond the towed object.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.2 Fairleads shall have a shape preventing excessive bending stress in the chain links/wire.

4.2.9.3 Each single chain or wire rope leg of the bridle shall have an effective (i.e. after any possible capacity reduction due to bending and/or end connections has been taken into account) $MBL_{leg} \geq 1.25 \times F_{TD}$ for $F_{TD} < 160$ t, and 40 t + F_{TD} for $F_{TD} > 160$ t. See also [4.2.1.7] and [4.4.5.5].

4.2.9.4 Connection items such as shackles, triangular plates, and rings in the bridle shall have an MBL greater than 1.3 times the required MBL_{leg}. See Guidance note to [4.2.8.6].

4.2.9.5 If two towlines (tugs) are connected to one bridle, the requirements in [4.2.9.3] and [4.2.9.4] should not be based on a F_{TD} of less than 0.9 times the sum of the F_{TD} for each tug.

4.2.9.6 The bridle apex connection shall be a triangular plate with drilled holes for the connection of shackles, or a similar suitable arrangement.

Guidance note:

The hole diameter and triangle (or 'delta') plate thickness (including cheek plates) should be adequate for an appropriate (centric) loading of the shackle (pin). A towing ring may also be found acceptable for short tows, but substituting the triangular plate with a shackle is not acceptable.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.9.7 The bridle opening angle at the apex should normally be between 45 and 60 degrees. If it exceeds 90 degrees the design load according to [4.2.9.3] shall be increased by a factor corresponding to the maximum theoretical bridle leg load, F_{leg}, for a towline load Ft_{owline} divided by the towline load $F_{towline}$.

4.2.9.8 A recovery wire rope should be fitted to the triangular plate, or - if single leg connections are used - to the end of the legs.

Guidance note:

The recovery wire rope should be led to a winch in an accessible position with the capacity to recover the bridle. The weight of the towline that it may be required to lift with the bridle should be considered. A wire rope MBL of not less than 6 times the weight of the bridle or leg is recommended apart from if less capacity is justified.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.10 Fairleads

4.2.10.1 The ultimate capacity (MBL) of fairleads shall not be less than the required single leg MBL_{leg} according to [4.2.9.3] and [4.2.9.5] if applicable.

4.2.10.2 Fairleads, including their (under deck) support structure, shall be designed to resist the load corresponding to the line pull defined in [4.2.10.1] from any likely direction. All possible directions, both vertical and horizontal, should be considered. See also Guidance note to [4.2.11.3].

4.2.10.3 The fairleads' design, size and position shall be adequate considering operational aspects.

Guidance note:

Fairleads should be of an approved type, located close to the deck edge. They should be fitted with capping bars and sited in line with the towline connections, to prevent side load on the towing connections.

Where the bridle might bear on the deck edge, the deck edge should be suitably faired and reinforced to prevent the bridle from chafing.

Where towing connections are of a quick-release type, then the fairlead design should allow all the released parts to pass easily through the fairlead.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.11 Towline connection points

4.2.11.1 The towing arrangement should normally be connected to the object using purposely designed towing connections.

Guidance note:

Normally, a Smit-type bracket should be used. However, other types of connections may be accepted based on thorough documentation of their strength, feasibility and actual condition.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.11.2 Towline connections, including their (under deck) support structure, shall be designed to resist the towline pull from any likely direction, considering the position of fairleads as applicable.

4.2.11.3 The ultimate capacity (MBL) of any towline connection (bracket, bollard and their foundations) shall not be less than the required single leg MBL_{leg} according to [4.2.9.3] and [4.2.9.5] if applicable.

Guidance note:

The above requirement could alternatively for welded steel structures be documented by calculations of the ULS (plastic) design capacity with the following input parameters:

- Design load (i.e. included load factor) in ULS = $0.85 \times MBL_{leg}$.
- Steel characteristic resistance, see DNV-OS-H102 Sec.5 A500.
- Material factor, see DNV-OS-H102 Sec.5 B400.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.2.11.4 Submerged (or close to the water line) towing brackets shall be designed to fail without perforating the towed object if the towing bracket is overloaded.

Guidance note:

Alternatively the ultimate capacity of such towing brackets should not be less than 1.3 × actual towline MBL.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3 Towing vessels

4.3.1 General

4.3.1.1 General requirements for towing vessels are given in DNV-OS-H101, Sec.6 D.

4.3.1.2 The towing arrangement, towlines, pennants, etc, shall comply with [4.2].

4.3.1.3 Proper documentation for the vessel(s) and equipment shall be available, see [4.3.10].

4.3.2 Criteria for selection of towing vessels

4.3.2.1 Only vessels intended for towing (e.g. with the class notation “tug”) shall be used for planned towing operations.

4.3.2.2 The vessel(s) shall fulfil the bollard pull requirement in [4.3.3] and have a trade certificate valid for the tow route.

4.3.2.3 Towing vessels shall also be selected with due consideration to the:

— tow route and towing procedure
— effective utilisation of the bollard pull
— manoeuvrability
— possible contingency situations.

4.3.2.4 The towing vessels shall be equipped with a towing winch, see [4.3.7]. Towing with hooks should only be used for assistance and in sheltered waters.

4.3.3 Bollard pull

4.3.3.1 The effective bollard pull (BP) shall be equal to or greater than the calculated towing force F_{TR} according to, as applicable, [3.6.2] and/or [3.6.3].

4.3.3.2 The effective BP shall be taken as the documented continuous static BP (see [4.3.10.2]) multiplied by relevant efficiency factors taking into account:

— the effect of waves and other environmental loads on the tug itself, see [4.3.3.3] and [4.3.3.4]
— propeller race interaction, see [4.3.3.6]
— more than one towing vessel, see [4.3.4].

4.3.3.3 In principle, the BP efficiency in a seastate should be calculated in each case considering the factors listed below. However, the type/size (represented by length) of the vessel and static BP are considered the most important factors. Hence, it is acceptable to find the BP efficiency as indicated in [4.3.3.4].

Guidance note:

Factors influencing the BP efficiency in a seastate:

a) continuous static BP
b) hull types (standard, X-bow or other shape)
c) size (length and width/depth/displacement)
d) wind area and shape
e) propeller (fixed or variable pitch) and /or thruster types (L drive, Z drive, Kort nozzle, etc), numbers, position and possible interaction
f) rudder types and interaction with selected propulsion
g) draft, trim and list
h) towline characteristics and towed object
i) stability and general behaviour vs environmental conditions
j) environmental condition in the towing area (type of sea and period) vs hull design
k) vessel's general condition and crew experience.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.3.4 Unless there are more accurate calculations or model tests of the towing efficiency of the tug (towing vessel) in the design environmental conditions, the efficiency factor is for tows defined by:

$$\gamma_{TE} = \left[80 - (18 - 0.0417 \times LOA \times \sqrt{BP - 20}) \times (Hs - 1)\right] / 100$$

Where:

γ_{TE}: Tug efficiency factor
LOA: Tug overall length, LOA = 45 m to be used for all LOA > 45 m
BP: Tug bollard pull, BP ≥ 20 t and BP = 100 t to be used for all BP > 100 t
1 m ≤ Hs ≤ 5 m, see [3.6].

4.3.3.5 Tugs with a length less than 35 metres are not recommended for ocean tows.

Guidance note:
Normally the tug length should be at least 40 metres for towage in harsh areas/seasons. Lengths less than 35 metres could be acceptable subject to documented tug feasibility.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.3.6 For towing with short towlines, the interaction effects due to propeller race between the tug and the towed object shall be considered in estimates of the required pull. Unless more accurate analysis is performed, an efficiency factor may be taken as:

$$\alpha_{int} = \left[1 + 0.015 A_{exp} / L_{towline}\right]^{-\eta} \qquad L_{towline} > 30 \text{ m}$$

where:

α_{int}: Interaction efficiency factor.
A_{exp}: Projected cross-sectional area of towed object in m^2.
$L_{towline}$: Towline length in metres.
h = 2.1 for typical barge shapes.
h = 1.7 for ship-shaped objects.

Guidance note:
See DNV-RP-H103 Sec.7.2.8 for further advice on the effect of propeller race/short lines.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.4 Towing fleets

4.3.4.1 The towing fleet's combined effective bollard pull shall be equal to or greater than the calculated towing force according to, as applicable, [3.6.2] and/or [3.6.3].

Guidance note:
A towing fleet is defined as more than one towing vessel or a self-propelled towed object assisted by one or more towing vessels. Any thrust from the towed object should be considered as a towing vessel (tug) in this sub-section.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.4.2 The combined effective fleet bollard pull shall be determined considering the effective bollard pull of each involved towing vessel and the:

— Towing fleet lay-out, see [4.3.4.3] and [4.3.4.4].
— Positioning tolerances, see [4.3.4.5], [4.3.4.6] and [4.3.4.7].
— Contingency requirements, see [4.3.5].

4.3.4.3 The combined bollard pull shall consider the possible pull direction of each towing vessel.

Guidance note:
In order to account for variations in the pull direction, a maximum of 95% of the calculated capacity as a single tug should be considered for the tugs pulling in the forward direction. It may be applicable to consider the "negative" pull from stern/steering tugs.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.4.4 Any asymmetric lay-out of the towing vessels that introduces a yaw moment on the towed object shall be accounted for in the combined effective bollard pull.

Guidance note:

The following possible effects of an asymmetric lay-out should be considered:

- The tugs cannot pull in the same direction without rotating the object.
- One or more tugs need to apply a reduced pull in order to avoid object rotation.
- The object rotates to an equilibrium position that causes the calculated towing force to increase.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.4.5 If the towed object needs to be kept at an earth-fixed heading (or heading range), this shall be duly considered in the fleet lay-out and in the required fleet bollard pull calculations.

4.3.4.6 If the towed object needs to be manoeuvred within strict tolerances, this shall be duly considered in the fleet lay-out and in the type of towing vessels used.

Guidance note:

The above is normally best achieved by utilizing a number of high-manoeuvrability type tugs.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.4.7 During manoeuvring within strict tolerances (e.g. during positioning), ample spare pull capacity should be provided.

Guidance note:

Normally with strict tolerances the fleet effective bollard pull should be at least twice the towing force calculated according to [3.6.3.3] in any direction. See also [4.3.5.4].

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.5 Towing vessel contingency

4.3.5.1 Spare equipment and arrangements shall be provided to reconnect any towing vessel in the case of towline failure. See [4.2.4], [4.3.6.8] and [4.3.6.9].

4.3.5.2 For single tug tows, assisting tugs shall normally be engaged at (re-)commencement of the towage and at arrival destination(s).

4.3.5.3 Adequate contingency shall be provided during sailing in narrow areas and/or in areas with heavy traffic.

Guidance note:

For a single tug tow, the following will normally be accepted as adequate contingency:

- An assisting/spare tug of adequate size (recommended).
- The applied towing vessel has sufficient pull capacity after a single failure in its propulsion system.
- The towed object is equipped with an emergency anchoring system that can be activated in the actual area within an acceptable time frame. See also [5.1.7.3] Guidance note.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---

4.3.5.4 During positioning, the towing fleet shall maintain adequate control over the unit during all phases of the operation with a loss of thrust from one tug.

4.3.5.5 The towing fleet's combined effective bollard pull shall take into consideration the failure of one tug in any sheltered defined hold area. See also DNV-OS-H101, Sec.6 D700.

4.3.6 Towline details and spare equipment

4.3.6.1 The requirements stipulated in [4.2.7] apply.

4.3.6.2 Tugs shall be equipped with suitable anti-chafing equipment.

4.3.6.3 A gog rope or alternative arrangement (e.g. a towing pod) shall be provided to prevent athwart ship pull from the towing line.

4.3.6.4 The gog rope should be mechanically operated and capable of being adjusted from a remote station. A spare shall be carried.

4.3.6.5 Where a towing pod is fitted, its strength shall be shown to be adequate for the forces it is likely to encounter. It should be well faired and the inside and ends must have a minimum radius of 10 times the towline diameter.

4.3.6.6 Where neither a towing pod nor gog rope is fitted, then an alternative means of centring the tow line should be provided. However, it is not recommended to tow with pins up.

4.3.6.7 On square-sterned towing vessels, it is preferable to fit mechanically or hydraulically operated stops near the aft end of the bulwarks to prevent the towline from slipping around the tug's quarter in heavy weather.

4.3.6.8 A spare towline shall be available on board. The spare towline should preferably be on a second winch drum. If the towline is not on a winch drum, a system for easy transfer of the spare towline to the winch drum shall be installed.

Guidance note:

For inshore tows, the spare towline may be substituted by another spare towing arrangement. Generally the spare towing arrangement should have the same strength and towing capability as the main towing arrangement.

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4.3.6.9 Additionally, the following spare equipment should be kept available on board the towing vessel and/or the towed object:

— 1 pennant
— 2 fibre rope springs, if used
— A suitable number of shackles, rings and other connecting equipment for at least one complete towing line configuration.

4.3.7 Towing winches

4.3.7.1 The towing winch shall be approved according to classification requirements.

4.3.7.2 Winches for open-sea towing should be remotely operated from the wheel house and so designed and instrumented that the loads in the wire rope can be determined from the drum.

Guidance note:

As examples, this may be arranged either directly by use of a load cell or indirectly when the brake is actuated by hydraulic pressure.

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4.3.8 Equipment for personnel transfer

4.3.8.1 At least one workboat with propulsion suitable for the safe transfer of personnel and equipment in open-sea conditions should normally be carried on board for transferring personnel and equipment from the towing vessel to the towed barge.

Guidance note 1:

If the workboat is of the inflatable type, a flooring of adequate strength should be fitted to allow the carriage of heavy objects.

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Guidance note 2:

The general requirement of a workboat may be disregarded if the following is complied with:

— The towing vessel is so manoeuvrable and fender protected that direct transfer of personnel to the towed object is as safe or safer than from a workboat.
— The towed object has adequate locations with sufficient strength for direct personnel transfer from the towing vessel.
— Any required emergency actions, such as releasing the towed object anchor, in the case of a towing vessel "black-out" could be done without using a workboat.

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4.3.9 Bunkers and other consumables

4.3.9.1 The towing vessel shall carry adequate supply of fuel and other consumables considering the tow route and the season.

Guidance note:

Consumables including potable water, lubricating oil and stores, should be sufficient for the anticipated duration of the towage plus a reserve of at least 5 days' supply. For tows likely to take more than 20 days the reserve should be increased to 7 days.

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4.3.9.2 If refuelling en route is proposed, this should be described in the towing manual. See [4.4.4.6].

4.3.10 Vessel documentation

4.3.10.1 The following main particulars should normally be described:

— name, signal letters, owners and port of registry
— main engine(s): manufacturer and number, maximum continuous output and corresponding r.p.m.
— static continuous bollard pull (BP)
— propeller(s): number, type, whether nozzle is fitted or not
— side thrusters (if fitted): position and thrust
— fuel capacity
— fuel consumption, tonnes per day
— stability particulars for departure and arrival loading conditions.

4.3.10.2 The effective continuous (static) bollard pull (BP) of the vessel shall be documented, normally by a bollard pull certificate issued or endorsed within the last 10 years by a body approved by an IACS member or other recognised certification body.

Guidance note:

In order to comply with the above requirement a renewed bollard pull test is required at least every 10^{th} year and also if the vessel has undergone significant structural- or machinery changes. The bollard pull certificate should state the test procedure. A bollard pull certificate that is more than 10 years old may be acceptable but the certified value should be reduced by at least 10% + 2% per year since the expiry date of the BP certificate.

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4.3.10.3 It should always be evaluated whether the actual static BP is adequately represented by the documented BP.

Guidance note:

The tug BP will/may decrease over time due to aspects such as:

— propeller blades/nozzle wear (normal wear or cavitation)
— hull aspects (fouling)
— engine general wear and tear
— reduced engine-equipment performance relating to propulsion.

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4.3.10.4 For the towing winch and towing lines, the following should be available:

— Certificate and particulars for the towing winch stating the manufacturer, type, maximum holding and stalling power.
— Certificates for the main and spare towing wire ropes, stating the manufacturer, diameter of rope, length, construction, nominal tensile strength of wires, breaking strength.
— A log for the towing lines giving the following information on each rope:

  — date taken into use
  — records of inspection
  — date of renewal of end sockets or other end connections
  — a report on any damage to the rope.

— Certificates for shackles, rings, pennants, fibre rope springs and other connecting equipment.

4.4 Towing operations

4.4.1 General

4.4.1.1 The guidance and requirements for operational aspects stated in [2.3] generally apply.

4.4.2 Towing criteria

4.4.2.1 Tow out criteria shall be established and agreed on for all towing operations.

Guidance note:

The reason for the tow out criteria is to allow time for familiarisation with the tow, and to ensure an adequate distance to shore in adverse weather conditions, see [4.4.4.4]. Hence, the towing vessel(s), towing arrangement/procedure, towed object and towing route/area need to be assessed. Any design imposed restrictions should also be considered – See [2.1.3].

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4.4.2.2 If not otherwise justified, the following maximum wind speeds should be forecasted for the first 24 hours of the tow:

— For unusual tows with a large wind area: 15 knots (BF 4).
— For “standard” tows: 20 knots (BF 5).
— For standard tows with a small wind area and a towing master familiar with the type of tow and towing route: 25 knots (BF 6).

4.4.2.3 If a longer duration than 24 hours is required to obtain adequate sea-room, see [4.4.4], the above limiting wind conditions should be forecasted for a period of at least 1.5 times the theoretical time required to obtain such sea-room.

4.4.2.4 The tow out should take place with good visibility. Due attention should be paid to the effects of snow, rain, fog, etc. This is particularly relevant if the tow master is unfamiliar with the area. Assistance from local pilots should be evaluated.

4.4.2.5 The towing criteria shall consider all the limitations imposed by weather restricted transports.

4.4.2.6 If applicable, towing criteria for approximating the coast and/or narrow waters shall be established and agreed on for all towing operations.

4.4.3 Weather forecast

4.4.3.1 Arrangements for receiving weather forecasts at regular intervals prior to and during towing shall be made.

4.4.3.2 Weather forecast requirements shall comply with DNV-OS-H101, Sec.4 C.

4.4.4 Routing, sea-room and navigation

4.4.4.1 The routing shall be chosen so that adequate bottom clearance and sea room are available during the towing. See also [4.5.4].

4.4.4.2 Consideration should be given to the navigational accuracy, environmental conditions and loads, motion characteristics of the unit, possible heel and trim effects, towing force, etc.

4.4.4.3 The latest edition of available sea charts should be used. An IMO-approved electronic chart display and information system (ECDIS) is acceptable.

4.4.4.4 The route planning should include a description of how to ensure adequate sea room in the case of weather conditions that exceed the standard towing criteria (see [3.6.2.1]) or a towline failure.

Guidance note:

Sea room is typically defined as the distance that the tow can safely drift without grounding or colliding with an offshore installation. In order to demonstrate adequate sea room, the following two cases should be considered:

Case 1 - In bad weather (outside good weather forecast periods): the distance drifted whilst the significant wave height is greater than 5m in a storm for that section of the voyage that includes the effect of any associated currents. The design storm for determining the required sea room will typically be the 1-year return after the end of a good weather forecast. The storm duration and prevailing directions may be estimated based on typical data for the particular site and on DNV-RP-C205, Figure 3-10.

It should be assumed that the tugs develop negligible effective pull, unless it can be shown that the actual tugs can safely develop such pull without overloading their deployed towing gear in the relevant water depths. This may be demonstrated by showing the results of towline tension monitoring in the relevant weather and towing conditions (including significant wave heights and periods, water depths, towline deployed lengths and other relevant towline properties). These should show that the towline yield stress (typically corresponding to about 40% of the wire break load) is not exceeded. These results may also be used to validate towline dynamic simulations to extrapolate the results for other conditions. If stretchers are used, then their fatigue life must be shown to be adequate.

The critical depth contours for grounding, allowing for roll, pitch and heave in the worst weather conditions at LAT, should be plotted in advance. The route should also be planned to avoid passing too close upwind or up-current of any platforms or other isolated obstacles, especially for single tug tows. The required sea room and the basis for its calculation should be included in the towing procedures/manual for the guidance of the tug captain(s)/towmaster.

The actual tow route may safely deviate from the planned route if the weather forecasts are favourable as long as the tow can obtain the required sea room before bad weather is likely to arrive.

Case 2 - When approaching a potential lee shore (with a good weather forecast): the distance drifted in the worst acceptable forecast conditions during the time taken to replace and reconnect a broken towline and/or disabled tug.

The acceptable forecast conditions should be included in the towage procedures /manual for a particular case. Approaching a potential lee shore should only be attempted without a good weather forecast if there is no practicable alternative.

Alternatively, an additional (connected) tug may be required to guard against a towline breakage or disabling of a single tug when approaching or leaving a lee shore.

The same philosophy should be followed when transiting "choke points" with limited sea room, or with a high collision risk, with the tow waiting for a suitable good weather window before committing to the approach.

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4.4.4.5 Assisting tugs should be engaged at the commencement of the towage, at any intermediate bunkering port and at the arrival destination, as appropriate.

4.4.4.6 Bunkering ports, if required, shall be agreed before departure. If it is not practical to take the tow into port, then alternative arrangements must be agreed which may include:

— Where the towage is by more than one tug, each tug in turn may be released to proceed to a nearby port for bunkers, subject to a favourable weather forecast. The remaining tug(s) should meet the applicable towing force requirements stated in [3.6].
— Relief of the towing tug by another suitable tug, which itself is considered suitable to undertake the towage, so that the towing tug may proceed to a nearby port for bunkers.
— Bunkering at sea from a visiting vessel subject to suitable procedures and calm weather conditions.

4.4.5 Towline control & seabed clearance

4.4.5.1 Adequate towline pull direction and length should be continuously ensured, see also [4.3.6].

4.4.5.2 During normal operation, the length of the towline should be adjusted at regular intervals to avoid chafing and/or towline bending fatigue at the stern rail.

4.4.5.3 The towline should have a sufficient clearance to the seabed throughout the towage.

Guidance note 1:

Tug masters should be cognizant of the towline catenary at all times, but particularly in shallow water to avoid towline abrasion or snagging on the sea floor. Ideally, this should be by monitoring the water depth, towline tension and deployed towline length from the tug stern combined with a method of calculating the towline maximum depth below sea level.

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Guidance note 2:

The following formula may be used to estimate the towline catenary:

$$C = L_{towline}^2 \times W / T_W$$

Where:

C: Catenary in metres
$L_{towline}$: Towline length in metres
W: Towline dry weight (mas) in kg/metres. (Typically; D = 52 mm, W = 10 kg/m)
T_W: Winch tension in N.

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4.4.5.4 Weather restrictions should be defined for areas where it is not considered convenient to deploy the minimum lengths indicated in [4.2.7.4] and [4.2.7.5] due to limited depth or manoeuvring restrictions. The weather restrictions should be selected so the needed/applied BP $\leq F_{TD} \times L_{towline}$ /1800 (or 1200), where $L_{towline}$ is the deployed towline length.

Guidance note:

Alternatively the F_{TD} as shown in [4.2.6] could be increased to allow $L_{towline}$ to comply with [4.2.7]. See also [4.4.5.5] below.

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4.4.5.5 If F_{TD} ([4.2.6]) is increased to allow a shorter towline the complete towing arrangement strength including towline, pennants, bridle, fairleads and towing connections ([4.2.7] through [4.2.1.1]) shall be correspondingly increased.

4.4.6 Towing clearances

4.4.6.1 See [2.3.4] regarding air draft requirements.

4.4.6.2 For requirements as to out-of-dock clearances see DNV-OS-H201, Sec.4 E200.

Guidance note:

The out of dock clearances (and corresponding procedures) may be found applicable for passing through other narrow channels too.

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4.4.6.3 Protrusions below the hull shall be considered.

4.4.6.4 The tow should normally be routed so that an ample under-keel clearance is maintained. The clearance requirements shall consider uncertainties in the available bathymetry data.

Guidance note:

Normally the clearance should be at least 5 metres (from LAT) for the towed object and tug in inshore areas and 10 metres in offshore areas. However, this may be inadequate if depth indications are based on (very) old surveys done by lead line which could have missed isolated pinnacles. In such cases additional surveys and/or other tow (transport) routes should be considered. See also [4.4.6.5] below.

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4.4.6.5 In surveyed (see [4.5.4]) areas and/or areas with regular verification of chart indicated depths, the calculated minimum clearance after considering all relevant effects should be the greater of one (1) metre or ten (10) per cent of the maximum draught, with a maximum value (before allowances for the effects stated in the Guidance Note) of 3 metres.

Guidance note:

Calculations of the under-keel clearance should as applicable take account of the effects of:

a) roll, pitch, heave and initial heel and trim
b) inclination due to wind
c) wind- and wave-induced slow drift motions
d) tow-line pull
e) tolerance on bathymetry
f) changes in the draught of the transport or towed object
g) differences in water density
h) low water tidal height variations
i) squat effects
j) deflections of the structure
k) errors in measurement (survey tolerances)
l) negative surge.

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4.4.6.6 The width of the towing route should normally be at least three times the maximum width of the towed object plus allowances for the tow yaw.

Guidance note:

The tow yaw will typically depend on the directional stability of the tow, towing configuration and the towing speed. The yaw should be conservatively assessed based on the following:

— relevant experience with similar tows
— theoretical evaluations/calculations based on tug configurations, see also [4.4.6.7] below
— model tests with a set-up to obtain realistic results for the yaw (and sway).

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4.4.6.7 Additional channel width may be required in exposed areas, if there are significant cross currents or if needed for the tugs to manoeuvre safely.

4.4.6.8 Narrow (normally defined as less than 5 times the width, including allowances for yaw) channels should be passed through only in favourable current and weather conditions, including good visibility. Special procedures may be required.

Guidance note:

Contingency should be considered, see e.g. [4.4.8.2].

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4.4.6.9 The sideways clearance to the first possible point of contact over or under water shall be considered.

4.4.6.10 For single tug tows, assisting tug(s) should be engaged for passing through narrow channels. See also [4.3.5].

4.4.7 Towing procedures

4.4.7.1 The tow shall be carried out according to agreed operational procedures, normally included in a towing manual. See also [2.2.4].

Guidance note:

The towing manual should normally contain detailed information regarding:

- towing (tow out) criteria
- any operational restrictions, see [2.3.3]
- criteria for seeking shelter
- towing route
- ports/areas of shelter
- estimated towing time (ETD, ETA)
- environmental limitations w.r.t. the object's structural capacity, seafastening, grillage etc.
- contingency actions
- description of the ballast condition
- reporting routines for the tow's progress, ETA, status, etc.
- contact persons and telephone numbers
- expected environmental conditions for the intended towing route for the relevant season
- procedures for departure and arrival as well as calls at intermediate ports (e.g. for bunkering).

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4.4.7.2 The towing manual shall be distributed to key personnel. See [2.3.4].

4.4.8 Mitigating actions and contingency

4.4.8.1 For large tows or towing close to shipping lanes, the use of a guard ship to prevent other vessels and objects from jeopardising the tow should be considered.

4.4.8.2 The presence of a riding crew on the towed object may also be relevant in narrow waters to pick up a towline, or release the anchor, in case of towline failure.

4.4.8.3 See [4.3.5] for towing vessel contingency requirements.

4.4.9 Inspections and testing

4.4.9.1 See [2.3.7] (DNV-OS-H101 Sec.4 F) for general requirements.

4.4.9.2 Before departure, an inspection of the towing vessel and towed object, including all parts of the towing arrangement, shall be carried out to confirm compliance with the above stated requirements.

4.4.9.3 The crew of the towing vessel(s) and boarding crew or permanent crew of the towed object shall be familiar with the equipment and installations which may be used during the voyage.

4.4.9.4 Functional testing of the towed object's machinery (equipment) that may be used during the voyage should be performed.

Guidance note:

The machinery (equipment) tests should be done (or at least witnessed) by the personnel who will/may operate the systems during towage. Normally, there should be a demonstration of the operation of the bilge and ballast systems, anchoring arrangement, etc. on the towed object before departure.

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4.4.9.5 Functional testing of towing winch systems shall as a minimum be carried out.

4.4.9.6 An inspection of the towing wire ropes shall be performed.

4.4.9.7 The towing line shall not be used if:

- the reduction in towline strength due to wear, corrosion and broken wires exceeds 10% and
- there is severe kinking, crushing or other damage resulting in distortion of the rope structure.

Guidance note:

The tow line should be subject to special evaluations if the number of broken wires over a length of 7 times the tow line diameter exceeds 6% of the total number of wires in the rope, if significant wear is found on the outer layer of wires or if the tow line is significantly corroded.

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4.4.9.8 Special attention shall be paid to the connection of end sockets and such sockets shall be renewed at regular intervals.

Guidance note:

If used to form the towline termination, the closed socket (normally spelter type) should be renewed at intervals not exceeding two years, irrespective of the condition of the socket and its wire. Except when re-socketed at sea for contingency reasons, socketing should only be done by a certified specialist contractor that is approved by an IACS member.

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4.5 Large tows

4.5.1 General

4.5.1.1 Large tows are defined as the towing of large self-floating objects or multi-barges (see [5.3]) by a towing fleet (see [4.3.4]).

4.5.1.2 The requirements in this sub-section should be considered as additional - or, where in conflict, as substituting requirements applicable for large tows.

4.5.2 Navigational equipment

4.5.2.1 The navigation of the towed object shall be monitored by means of two independent systems.

4.5.2.2 The secondary system should be separate from the primary system, both in principle and location.

4.5.2.3 At critical phases of the towage such as when departing from a mooring location, towing in narrow waters and arrival, both systems should be used as a cross-reference to each other.

4.5.2.4 For towing in narrow channels and for accurate positioning, the compatibility of the navigation equipment on board the survey ship and lead tug should be verified by tests carried out prior to commencement of the tow.

4.5.3 Clearances

4.5.3.1 The requirements in [4.4.6] generally apply, but for large tows where position control and surveys are normally enhanced, see [4.5.2] and [4.5.4], the minimum width of the towing route could be reduced pursuant to agreement. Sufficient clearances for the towing fleet to manoeuvre adequately should be ensured. Note also especially [4.4.6.7].

4.5.3.2 The clearance to shore in wave sheltered holding areas should not be less than 2 nautical miles.

4.5.4 Survey of towing route

4.5.4.1 For large tows or towing in restricted waters, a special bottom survey of the intended towing route and receiving site should be carried out.

4.5.4.2 The survey should cover an adequately wide route to ensure that no unknown hazards exist which might hamper the tow.

Guidance note:

Normally, a survey using side scanning sonar will be adequate. If the underkeel clearances are close to the limit, bathymetric data should be provided. The survey should not be older than 3 months and should normally cover a width of 5 times the beam, with a minimum of 500 metres.

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4.5.5 Monitoring

4.5.5.1 The following should be considered to be monitored manually or by monitoring systems during the towing operation:

— water level, air pressure, etc, for buoyancy tanks
— position and orientation relative to the towing channel
— draught, heel and trim
— underkeel clearance and
— environmental conditions.

SECTION 5 TOWED OBJECTS

5.1 General

5.1.1 Application

5.1.1.1 This section is generally applicable to all types of towed objects. Specific requirements for some types of towed objects are given in sections [5.2] through [5.5]. See also DNV-RP-H203 for special requirements for MOUs (semi-submersible and jack-up rigs).

5.1.1.2 The requirements in Sec.2, Sec.3 and Sec.4 that are relevant for the towed object apply.

5.1.2 Loads and structural strength

5.1.2.1 The structural strength of the towed object shall be documented considering all relevant loads. See also Sec.3.

5.1.3 Stability and seaworthiness

5.1.3.1 Adequate intact and damaged stability and safety against the entry of water shall be documented. See DNV-OS-H101, Sec.5 for detailed requirements.

5.1.3.2 The acceptable seaworthiness of towed objects shall be documented for the intended towing route.

Guidance note:
A certificate from the class society (or statutory authorities) documenting seaworthiness will normally be required for a towed vessel. For other towed objects, the seaworthiness needs to be documented through analysis/calculations and surveys in each case.

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5.1.3.3 If used, it should be documented that the specified slack tanks will not jeopardise the stability or strength of the towed object.

5.1.3.4 If the object for any reason, see [4.2.3.2], is towed by the stern, adequate stability, seaworthiness and strength shall be documented for this towing condition.

5.1.4 Manned towed objects

5.1.4.1 The manning of tows should normally be limited to those where early intervention by the riding crew can reduce the risk to the tow.

5.1.4.2 The organisation, qualifications and training of the riding crew shall comply with applicable national and international regulations.

5.1.4.3 The accommodation, consumables, lifesaving appliances, fire-fighting equipment and facilities for communicating with the towing vessel shall comply with applicable national- and international regulations.

5.1.5 Towing and navigation equipment

5.1.5.1 Towing equipment on the towed object shall comply with the requirements stipulated in [4.2], i.e. [4.2.3], [4.2.4], [4.2.9], [4.2.10] and [4.2.11].

5.1.5.2 The requirements for navigational lights and shapes are given in DNV-OS-H101, Sec.6 D500.

5.1.5.3 If the towed object may offer a small response to radar, the fitting of equipment identifying the object's position shall be considered.

5.1.5.4 If the navigation equipment is installed on board the towed object and the towing operation is conducted from here, compatibility and tests as per [4.5.2.4] apply.

5.1.6 Access

5.1.6.1 The towed object, whether manned or not, shall be equipped with adequate access means.

5.1.6.2 The access means shall allow safe entry in all relative sea and towed-object directions. Normally, this implies that proper (preferably recessed and in good condition) steel ladders from sea level to deck are available on both sides of the towed object.

5.1.7 Emergency anchoring

5.1.7.1 A towed object should normally (see [5.1.7.3]) have at least one adequate anchor available for emergency anchoring.

Guidance note:

An adequate anchor should normally:

— be secured with an easy release arrangement
— have a minimum weight of 1/10 of the calculated towing (holding) force (see [3.6])
— be connected to a minimum 200 metre-long cable with an MBL of minimum 20 times the anchor weight.

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5.1.7.2 A windlass or similar arrangement should be capable of paying out and holding the anchor.

5.1.7.3 An emergency anchor could be substituted by alternative arrangements defined based on a risk assessment for each (type of) towage.

Guidance note:

The risk assessment should consider at least the following:

— use of anchor if fitted - practical (and safe) in an emergency situation
— tow route, including (missing) anchoring possibilities
— weather restrictions and prevailing weather conditions
— towing vessel(s), i.e. propulsion redundancy, type, condition and “track record”
— additional tugs (escorting or on call),
— bridle reconnection possibility (if both the main and spare towline have failed)
— whether the towing vessel anchor(s) may be useful or not
— whether an escort (on call) tug can be easy connected to the (broken-down) towing vessel and towed object.

Alternative arrangements could e.g. consist of one or more of the following actions:

— redundant towing vessel/fleet (see [4.3.5])
— escort (or on call) tug when near coastlines
— weather restrictions (e.g. on wind/wave direction or to ensure that the towing vessel capacity is adequate after a single failure) when approaching coastlines.

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5.1.8 Mooring equipment

5.1.8.1 Except for tows which cannot enter harbour, e.g. large self-floating objects, a suitable number of mooring ropes of adequate strength and length shall be available on board.

5.1.9 Ballast and drainage systems

5.1.9.1 Adequate ballast pumping arrangements should normally be available for any towed object.

Guidance note 1:

The required pump capacity and lay-out should be based on the planned use and possible emergency need for ballasting. The pumping ability for the following should, as found relevant, be evaluated:

— adjusting of agreed departure condition
— required ballasting before/during/after discharge (e.g. lift off from barge offshore)
— reduce/adjust draft/trim due to shallow waters
— ballasting due to air draft restrictions
— correction of unintended flooding
— de-ballasting after accidental grounding
— ballasting to allow work below normal waterline
— access to flooded compartment (e.g. pump or anchor winch room).

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Guidance note 2:

If ballast pumps are not fitted or are out of order, it will normally be acceptable to arrange the required pumping capability using portable pumps placed on board the towed object.

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Guidance note 3:

The pumping capability requirement may be waived for some un-manned self-floating objects and barges. A risk assessment considering the items listed in Guidance note 1 should be carried out.

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5.1.9.2 For classed towed vessels, the drainage system and (bilge) pumps should as a minimum comply with the Rules of the Classification Society.

5.1.9.3 For unmanned towed objects, it should be documented that the tug crew are familiar with the pumping system and are able to board and run the pumps at short notice.

5.1.10 Seafastening

5.1.10.1 For guidance and requirements for seafastening on board the towed object, see [3.5].

5.2 Barges

5.2.1 General

5.2.1.1 For general requirements for barges, see DNV-OS-H101 Sec.6 D, and for general requirements for towed objects, see [5.1] above.

5.2.1.2 Unclassed barges shall be subject to appropriate project-specific structural, equipment and machinery checks. They shall have a valid load line, or load line exemption, certificate.

5.2.2 Stability and towing condition

5.2.2.1 For general stability requirements, see [5.1.3]. For requirements for barges, see DNV-OS-H101 Sec.5 B.

5.2.2.2 In order to improve sea-keeping and avoid slamming, it is recommended that the towed barge is trimmed minimum 0.005 times the barge length by stern, and ballasted to a draft at bow of minimum 0.022 times the barge length.

Guidance note 1:

Another trim may be found beneficial for some barges, e.g. where barges with faired sterns are fitted with directional stabilising skegs, it may be preferable to have no trim. This should normally be documented in the Trim and Stability booklet. However, allowance should be made for trim caused by the towline force and there should be adequate freeboard at the bow (and possibly a breakwater) to minimise damage from “green water” coming over the bow.

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Guidance note 2:

A reduced minimum draft at the bow may be considered in benign weather areas and during summer in other areas. Normally the draft should be at least 0.02 times the barge length.

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5.2.3 Anchoring and mooring equipment

5.2.3.1 The general requirements for anchoring equipment are given in [5.1.7].

Guidance note:

Further guidance may be obtained from DNV Ship Rules, Pt.3 Ch.3 Sec.3.

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5.2.3.2 It is recommended to have at least 4 mooring ropes of 110 m each (or 2 of 220 m each) available on board barges.

5.2.4 Barge global strength

5.2.4.1 The global barge capacity shall be confirmed. For barges or vessels classed with a recognised classification society, it is recommended to base the global strength verification on stated allowable shear and bending capacities.

5.2.4.2 For barges without class, the global strength shall be verified according to DNV-OS-H102. The verification shall consider all relevant loads and load combinations, i.e. hydrostatic loads, hydrodynamic loads, motion and weights shall be evaluated.

5.2.5 Barge local strength

5.2.5.1 The barge local strength shall be verified. Local strength verifications shall consider the actual barge condition, i.e. the effects of corrosion, local damage and structural modifications shall be taken into account.

5.2.5.2 If the allowable deck load is based on “load charts”, these shall clearly state limitations and/or conditions with respect to the number of loads, spacing between loads and number of simultaneously acting loads. It shall also be clarified whether the stated capacities include or exclude dynamic loads and whether any design/load factors are included or not. Applied load and material factors shall be specified.

Guidance note:

The approved “load chart” should be used with care, especially for heavy objects (> 500 tonnes). For highly loaded barges, separate analyses/calculations are recommended to verify the local deck strength.

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5.2.6 Barge documentation

5.2.6.1 A general description of the barge systems shall be presented. Ballast and towing equipment/systems shall be described in detail.

5.2.6.2 The following main particulars should as a minimum be described:

— object particulars
— name, signal letters, owners and port of registry of barge
— draught during towing
— stability properties for intact and damaged conditions
— specification of anchoring and mooring equipment
— the class of the barge (if any), length, breadth, depth and year of build, etc.

5.2.6.3 The following main drawings should normally be presented:

— general arrangement
— load charts if applied
— midship section, longitudinal section and other plans for a structural strength evaluation if such evaluation is found necessary
— drawings showing the arrangement and scantlings of towing brackets, bollards and fairleads
— the main and emergency towing arrangements
— recovering arrangement.

5.3 Multi-barges

5.3.1 Application

5.3.1.1 This section applies to transport of heavy objects on multiple barges (or other multiple vessels).

5.3.1.2 The requirements in [4.5] generally apply for multi-barge (vessel) transports.

5.3.2 Vessels

5.3.2.1 Each of the vessels (barges) shall comply with the requirements stipulated in [5.1] ([5.2]).

5.3.3 Ballasting systems

5.3.3.1 The ballasting system on each vessel should be capable of redistributing loads due to the flooding of any one vessel compartment.

5.3.3.2 Spare parts (blind flanges, leak mats, welding equipment, etc) should be available on board the vessel in case of leakage. Regular inspections of the air pressure and water level in the vessel tanks should preferably be carried out during the transportation.

5.3.4 Stability afloat

5.3.4.1 The multi-barge damage stability requirements in DNV-OS-H101, Sec.5 B400 are generally applicable for all types of multiple vessel transports.

5.3.5 Design considerations and analysis

5.3.5.1 The barge ballasting condition should be optimised to ensure a favourable load distribution in the barges and the transported object.

5.3.5.2 The strength of local support points in the grillage and transported object shall be verified. See also [5.3.6] and [5.3.7].

5.3.5.3 An adequate analysis shall be conducted in order to accurately assess the support loads acting on the individual barge (vessel) supports.

Guidance note:

An advanced integrated analysis including the object and vessels and taking proper account of the barges' individual responses is normally required.

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5.3.5.4 Accidental load cases should include the collapse of one arbitrary grillage support element unless such cases are found irrelevant based on a risk assessment.

Guidance note:

By "grillage support element" is meant stiffeners, plate fields, girders etc that may be damaged during the operation. Elements exposed may be identified from relevant accident scenarios. The collapse of an element may be considered by neglecting the element in the structural design analysis.

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5.3.5.5 Force distributions and deflections in the transported object and barges (vessels) shall be determined and considered in the design calculations. See also DNV-OS-H102 Sec.4 A800.

5.3.5.6 The seafastening structures shall be sufficiently flexible as to accommodate the relative deflections and avoid overstressing the transport object or barges.

5.3.6 Skew loads

5.3.6.1 Skew loads are loads due to fabrication and operation tolerances, offset, inaccuracy, etc, and shall be considered for the transported object, barge supports, etc.

5.3.6.2 The following skew load effects should be considered:

- fabrication tolerances for the transported object and barge supports
- fabrication tolerances for the barges
- vertical offset of the transported object for each support condition
- barge heel and trim
- movement of the barge centre of buoyancy, gravity and flotation relative to the draught and ballast configuration
- inaccurate positioning of barges relative to the transported object's supports
- deformation of the transported object and barges, including the possible introduction of horizontal loads
- other relevant effects.

5.3.7 Barge supports

5.3.7.1 The flexible support system (crushing tubes, lead plates, shock absorbers, wedge arrangement, etc) shall have sufficient capacity to account for the deflections of the deck and barges during transportation conditions.

5.3.7.2 The flexible support system shall be designed according to a fail-to-safe philosophy, i.e. the supports shall resist overloading without total collapse.

5.3.7.3 To avoid progressive deflections due to dynamic loading of the supports, a "fall back" securing arrangement should be considered, see also [5.3.5.6].

5.4 Ships

5.4.1 General

5.4.1.1 This section applies to towing of ship's hulls or ships including demolition towages and, as appropriate, towages of FPSOs.

Guidance note:

It is recognised that all ships are different and that particular problems which may exist for the ship(s) in question may require special solutions/arrangements to fulfil the general requirements for towed objects in [5.1]. This section provides guidance and requirements for such possible solutions/arrangements.

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5.4.2 Manning

5.4.2.1 See [5.1.4] for guidance and requirements.

5.4.2.2 Passenger ships and ro-ro ships will generally only be approved for towage if the tow is manned and will permit early intervention in the event of any problems.

5.4.3 Stability, seaworthiness and structural strength

5.4.3.1 The general stability, seaworthiness and structural strength requirements are given in [5.1.2] and [5.1.3].

Guidance note:

For ships that have a valid class with a recognised classification society, and possess a current Load Line or Load Line Exemption Certificate, the general requirements referred to should suffice. However, for ships with (significant) damage and/or without valid certificates, additional assessments are required in order to verify that the structural strength and watertight integrity of the tow are acceptable for the intended voyage. In this case, one or more of the following mitigating actions are required:

a) An extended, in-depth survey of the vessel structure involving one or more specialist surveyor(s). Facilities for a close-up survey of inaccessible parts of the hull structure may be required.
b) Thickness determination (gauging) of specified areas of the vessel structure. This survey may be in limited areas or extend over large parts of the hull structure. Such surveys should be carried out by a reputable independent company. An existing survey report may be acceptable provided it is not more than 1 year old and there is no evidence of damage or significant deterioration since that date.
c) Review of scantling drawings approved by a classification society.
d) Calculations to show that the structural strength of particular local areas of the vessel is adequate. The extent of the calculation required to be determined by the results of the surveys and document/drawing review.

The towage of any vessel which is damaged below the waterline, is suspected of being damaged below the waterline or has suffered other damage or deterioration which could affect the structural strength is normally not acceptable unless a survey and calculations clearly show that the vessel's strength and watertight integrity are satisfactory for the intended towage.

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5.4.3.2 Should any doubt exist as to the ability of the ship to complete the proposed towage after all possible surveys and calculations have been undertaken, a dry dock survey of the ship shall be conducted and repairs and/or temporary strengthening should be carried out as found necessary.

5.4.3.3 Any heavy fuel oil within the vessel's tanks must be identified and shall be minimized where possible. In the event of heavy fuel oil being carried, possible limitations on entry to ports of refuge and ports of shelter shall be noted and taken into account in the towage procedures.

Guidance note:

To minimize the risk of pollution, the requirements of the IMO MSC/Circ.884, paragraph 13.19, should be taken into account as far as is practical.

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5.4.4 Towing and navigation equipment

5.4.4.1 The towing equipment on the ship shall generally comply with the requirements stipulated in [4.2.4], [4.2.9], [4.2.10] and [4.2.11].

5.4.4.2 Non-standard solutions/arrangements for the towing equipment on the ship may be acceptable if adequate strength, redundancy and functionality are documented.

Guidance note:

Each ship towage is unique and it is therefore not possible to specify in detail in this Standard the connection equipment to be used and how it is to be attached in every case. The criticality of (minor) damage to the towed object and the time available for making the arrangement may/should be considered.

Unless the ship has been fitted with proper towing brackets or the anchor chain and windlass are used, it may be necessary to utilise attachments such as mooring bitts to connect to the tow. If necessary, reinforcements should be fitted to achieve the required capacity, otherwise alternative arrangements must be made.

The configuration of the attachments to the tow may be one of the following depending on the circumstances and equipment available:

a) chain bridle with bridle leg from each side of the bow
b) single chain from centre line location or forward fairlead
c) anchor chain(s) from ship’s hawse pipe(s)
d) single continuous chain with the ends extending out from each bow
e) single continuous chain, or chain and wire combination, around a part of the, or the whole, ship superstructure.

Chain chafing may occur when unsuitable fairleads have to be used or the tow yaws significantly. In these cases, an oversized chain should be provided.

A bridle is most suitable for tows which have a wide bow. In any event, the angle at the apex of the bridle should not exceed 60º. A triangle plate, delta plate or towing ring should be fitted at the apex of the bridle. For tows which have a sharp bow configuration, a single chain pennant passing through a bow centre line or forward fairlead may be preferred.

If deemed appropriate an anchor chain from the tow may be used after removal of the associated anchor. The condition and capacity of the chain should be duly assessed. If such a method is utilised, appropriate safety measures should be implemented as follows:

a) windlass in gear
b) windlass brake applied
c) chain claw or stopper deployed
d) back-up wire to connect the chain to the base of the windlass or other suitable securing point.

A single chain passing through one side fairlead, around a strongpoint such as the windlass base and out of a fairlead on the other side may be acceptable. An alternative arrangement may consist of a single chain passing up one hawse pipe and out of the other. In either case, the outboard ends should be made up into a bridle. Each leg should have preventers on the inboard side to stop the chain from sliding. The arrangement should not interfere with the vessel's emergency anchoring arrangements.

Where mooring bitts are utilised to secure the chain to the tow, and in order to ensure that the towing arrangement is securely anchored on the vessel and does not slip on the bitts, the chain should be backed-up to further bitts abaft the main connection points using suitable wire pennants locked into position with clips. If such an arrangement is used, then the first bitts used must have the required ultimate capacity, unless positive load-sharing can be achieved. Bitts and fairleads should be capped with welded bars or plates of sufficient strength to prevent equipment jumping off or out of the arrangement.

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5.4.4.3 See [5.1.5] for guidance and requirements for navigation equipment.

5.4.5 Securing of rudder and propeller

5.4.5.1 The rudder must be secured in a centreline position before the start of the towing operation. The adequate strength of the securing arrangement should be documented.

5.4.5.2 When propellers are not allowed to free-wheel, the shafts should be locked by an installed shaft-locking device or other suitable method. The adequate strength of the locking arrangement should be documented.

5.4.5.3 If propellers are allowed to free-wheel, propulsion machinery must be disconnected from the shafts or adequate lubrication provided. The stern gland on the shaft will normally be water-lubricated. Provision for this must be made while at the same time ensuring that the water does not flood the space.

5.4.6 Anchoring and mooring equipment

5.4.6.1 The general requirements for anchoring equipment are given in [5.1.7].

5.4.6.2 Anchor cables shall be properly secured with the windlass brake applied. Any additional chain stopper arrangements that are fitted shall be utilized or, alternatively, removable preventer wires shall be deployed.

5.4.6.3 Spurling pipes into chain lockers on un-manned tows should be made watertight using foam plugs or some other satisfactory method.

5.4.7 Loose equipment and cargo

5.4.7.1 Every effort shall be made to limit the carriage of any loose deck equipment to an absolute minimum. Where equipment must be carried on an exposed deck, it shall be protected and secured against movement using welded brackets, chains or wires. Equipment in other areas shall also be secured.

5.4.7.2 In general, all equipment shall be secured to meet the appropriate requirements relating to motion (see [3.2]) and seafastenings of loose items designed in accordance with [3.5.9].

5.4.7.3 A towed ship should not normally carry manifested cargo unless the tow is manned and is fully classed by a classification society, including the possession of a current International Load Line Certificate.

Guidance note:

If cargo is carried, the following guidance applies:

a) International Load Line Regulations should be strictly followed.
b) A cargo plan should be provided/made.
c) The cargo should be loaded making proper allowances for load distribution both during loading and for the duration and route of the towage. Longitudinal strength requirements should be complied with.
d) Bulk cargoes should be properly trimmed to prevent shifting in a seaway. Shifting boards or other preventative methods should be utilised where appropriate.
e) All other cargoes should be secured in accordance with [3.5].

f) Particular attention should be paid to the securing of scrap steel, which if carried should be properly seafastened. If carried in a hold, it should not be treated as a bulk cargo.

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5.4.8 Towage of floating production, storage and offload vessels

5.4.8.1 The guidelines and requirements in this sub-section [5.3] generally apply to the towage of FPSOs, and similar large vessels.

5.4.8.2 For FPSOs, the following aspects must be given special consideration:

— structural limitations including fatigue during tow
— tow routing and tug selection
— directional stability of tow (fish tailing)
— optimal ballast condition and trim for the tow force/stability/hull beam strength
— adequate towing equipment considering high freeboard, etc.
— use of the FPSOs thrusters, if applicable
— planned manning and requirements to certification
— how to fulfil emergency anchor equipment requirements
— need for temporary/emergency moorings.

Guidance note:
Further guidance may be found in 0030/ND, section 21.

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5.5 Self-floating objects

5.5.1 Application

5.5.1.1 This section applies to the towing of objects such as gravity base structures, jacket substructures, offshore towers, etc supported by their own buoyancy and pushed/pulled by tugs.

Guidance note:
For towing gravity base structures, additional guidance may be found in 0015/ND, sections 8 and 11.

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5.5.1.2 The requirements for towed objects in [5.1] generally apply.

5.5.2 Stability afloat

5.5.2.1 See DNV-OS-H101, Sec.5 C for requirements for the stability of self-floating objects.

Guidance note 1:
Note that a GM < 1.0 m could be acceptable provided the stability range is adequate and any possible dynamic effects, see DNV-OS-H101, Sec.5 D200, are duly considered.

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Guidance note 2:
In special circumstances, the damage stability requirements may be relaxed for some types of structures. See 0030/ND section 10.7 for further guidance.

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5.5.3 Buoyancy

5.5.3.1 The buoyancy of the self-floating object shall be estimated on the basis of an accurate geometric model. The buoyancy shall be estimated for all relevant draughts. The position of the centre of buoyancy shall be estimated accordingly.

5.5.3.2 The effect of possible variations in buoyancy shall be considered. See DNV-OS-H102, Sec.4 A200.

5.5.4 Rubber diaphragms

5.5.4.1 Rubber diaphragms shall have sufficient strength to withstand internal and external water head or air pressure, including loads due to temperature changes after assembly. The rubber diaphragms shall also be capable of withstanding relevant hydrodynamic drag and inertia forces during towing.

5.5.4.2 Rubber diaphragms should be protected against wear, heat and frost after assembly.

5.5.5 Structural strength

5.5.5.1 The structural strength shall be documented/verified, see [5.1.2].

5.5.5.2 All relevant loads shall be taken into account. See [5.5.6] and [5.5.7] for loads that may be of special interest for self-floating objects.

5.5.6 Hydrostatic loads

5.5.6.1 Hydrostatic loads due to external water pressure on submerged structures or internal water pressure in water-filled compartments should be considered.

5.5.6.2 The characteristic hydrostatic loads should be based on the most severe draught or hydrostatic head for the individual structure or compartment.

5.5.6.3 Buoyant compartments exposed to external water pressure should normally be designed to withstand hydrostatic loads for all relevant draughts without pressure compensation by means of air pressurisation.

5.5.7 Other loads

5.5.7.1 All other significant loads occurring during the operations should be considered. In particular, the following effects should be considered during towing:

- wave slamming loads
- vortex shedding due to aerodynamic and hydrodynamic drag forces
- interaction between the towed object and propeller race
- increased draught due to interaction between the seabed and towed object
- channel effects in narrow passages.

5.5.7.2 Special consideration should be given to the local load effects of slamming, sloshing and increased weight from water on deck on structures with a low free board.

5.5.7.3 Auxiliary and permanent buoyancy tanks, similar buoyant structures and attachments to the towed object should be designed to withstand the buoyancy forces presented in [5.5.6], as well as environmental loads, slamming loads, etc.

SECTION 6 SHIP TRANSPORTATION

6.1 General

6.1.1 Application

6.1.1.1 This section applies primarily to sea transportation of special cargoes (see [1.1.1] Guidance note 1) on deck or in cargo holds of ships, but most of the requirements and guidance are applicable for special cargo sea transports on any type of manned vessel.

6.1.1.2 Specific requirements and guidance for transportation on HTVs is given in Sec.7.

6.1.1.3 Any recommendations from the class society shall be considered, see also [2.2.3.1].

6.1.2 Planning

6.1.2.1 The planning of ship transportation operations shall comply with the requirements in [2.1].

6.1.2.2 Any changes in the transport vessel schedule or late change of vessel should, if relevant, be considered.

6.1.2.3 If applicable, it should be ensured that other cargoes transported on the vessel will not significantly increase the risk.

Guidance note:

Other cargoes mean cargoes that are not included in the planned/documented transported object(s). Such cargoes could increase the risk by:

— Possibly causing impact damage to the ship and object if their seafastening is not adequate.
— Jeopardizing the ship stability if they are shifted.
— Additional handling/re-positioning of object(s) to give space for loading of other cargo.

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6.1.2.4 The ship stability shall generally fulfil the relevant class or statutory requirements, see DNV-OS-H101, Sec.5 A.

6.1.3 Documentation

6.1.3.1 All relevant aspects concerning the ship transport shall be properly documented, see [2.2].

6.2 Design

6.2.1 General

6.2.1.1 See [3.1] for general design requirements.

6.2.2 Motions, accelerations and loads

6.2.2.1 All applicable loads shall be considered, see [3.3].

6.2.2.2 It is recommended that the ship accelerations are calculated by a motion response analysis, see DNV-OS-H102, Sec.4 B.

6.2.2.3 Simplified accelerations may be calculated according to DNV Ship Rules, Pt.3 Ch.1 Sec.4 C500 - Deck cargo units. The following should be taken into account:

a) The factor for active roll damping should not be used.
b) The heavy object (reduced) accelerations consider the “normal” behaviour of the vessel captain, i.e. extreme weather conditions are avoided if possible and any extreme vessel motions are reduced by adequate vessel manoeuvring.
c) The vessel GM influences the transverse accelerations significantly and it should be ensured that it is within the applied value throughout the transport. As it may be difficult to ensure this, it is recommended that a conservative value is applied and that a GM < B/13 is normally not considered.
d) Likewise, if not known, the C_b factor shall be chosen conservatively.
e) The part of the DNV Ship Rules that states the simplified accelerations is valid only for ships with a length L > 100 m.

Guidance note 1:

The formulae in the DNV Ship Rules may be used to find 10^{-8} probability level accelerations for ships with a length of less than 100 metres too. However, for these ships, the reduction factors used to find the single transport (heavy object) accelerations should be multiplied by a factor of $F_L = 1 + 0.5 \times (100\text{-}L)/50$ for 100 m > L > 50 m. For L ≤ 50 m the calculated 10^{-8} accelerations should be applied directly. See [1.3.3] for a definition of the ship length L in this context.

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Guidance note 2:

The transport accelerations indicated in DNV 2.7-3 may be applied in cases where the transport vessel particulars are not known.

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6.2.2.4 The accelerations for deck cargo units should only be used for single transports of limited duration.

Guidance note:

Limited duration normally means maximum of 30 days (T_{POP}) for world-wide transports. Any sailing time in benign weather areas could be disregarded. For transports in potentially harsh weather conditions (e.g. NCS outside the summer season), a maximum of 7 days should be considered. For a T_{POP} that is greater than indicated, the deck cargo accelerations should be increased as shown in the table below.

Duration (T_{POP})	$T_{POP} \leq 7$ days	7 days < $T_{POP} \leq 30$ days	30 days < $T_{POP} \leq 180$ days	$T_{POP} > 180$ days
Word-wide	0%	0%	20%	50%
Harsh conditions	0%	20%	35%	50%

For transports that can seek shelter in the case of forecasted extreme weather conditions and will do so according to the operation procedure, $T_{POP} \leq 7$ days may be applied.

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6.2.2.5 For large objects, the effect of rotational inertia should be taken into account.

6.2.2.6 Characteristic loads shall be combined, factored and analysed according to DNV-OS-H102 Sec.4 C300.

Guidance note:

The maximum horizontal acceleration should be combined with both the minimum and maximum vertical acceleration. Beam and head sea may be treated as two separate load cases. Quartering sea should also be included if deemed critical for any structural element. (See also IMO Res. A.714(17), Annex 13 regarding allowable angles of securing devices.) Quartering sea could be included by combining 80% of the horizontal transverse and 60% of the longitudinal acceleration with both the minimum and maximum vertical acceleration.

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6.2.3 Structural design

6.2.3.1 Structural design calculations shall comply with DNV-OS-H102, Sec.5. See also [3.1.3].

6.2.3.2 If applicable, the adequate structural strength of the deck and hatches shall be documented.

Guidance note:

Load-distributing grillage elements may be required to avoid local overloading of deck structures, including hatches. See [3.4].

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6.2.3.3 If cargo is transported on and/or secured to hatches, the adequate strength and functionality of the hatch connections in both a vertical and horizontal direction shall be documented.

Guidance note:

See DNV Ship Rules, Pt.3 Ch.3 Sec.6E for (DNV GL) Class requirements for hatch covers.

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6.2.4 Seafastening including lashing

6.2.4.1 See [3.5] for general requirements for seafastening and grillage.

6.2.4.2 Calculations of characteristic lashing seafastening loads shall take into account the cargo CoG, support layout, friction and location/direction/stiffness of each lashing. In undetermined seafastening arrangements, the loads may be calculated based on a quasi-static load distribution combined with an appropriate skew load factor, see [6.2.4.3].

Guidance note:

The applicable design friction coefficients are listed in [3.5.3.4].

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6.2.4.3 Possible skew loads in lashings due to uneven pre-tensioning and length/stiffness variations in statically undetermined seafastening arrangements shall be taken into account. The design loads for lashings should be multiplied by a skew load factor not less than 1.5 if skew load effects are not accurately calculated.

Guidance note:

A skew load factor of 1.5 is considered adequate if lashings carrying the same (quasi-static) load component between them have approximately the same stiffness and similar means of pre-tensioning. If not, conservative assessments should be conducted to estimate the applicable skew load factor(s).

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6.2.4.4 The design resistance for lashings used in seafastening shall not be greater than the MBL divided by the appropriate material factor according to DNV-OS-H102, Sec.5. The MBL shall not be greater than the certified MBL with applicable reductions according to [6.2.4.5] and due to the possible effects of wear and tear and actual use (e.g. twist and temperature).

Guidance note:

The material factors stipulated for fibre ropes may be used also for webbing strops of the same material. For lashings without a certified MBL, the design resistance may normally be equal to the certified SWL (WLL) multiplied by the applied LRFD load factor (normally 1.3).

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6.2.4.5 Possible reductions in MBL due to bending shall be taken into account.

Guidance note:

Recommendations regarding wire and fibre ropes are given in DNV-OS-H205, [4.1.5].

Regarding chains, the following apply if not properly documented otherwise:

— Chains should not be bent around edges with a diameter of less than 4 times the chain diameter. Two times the chain diameter may be acceptable for up to 90 degree edges.
— The effective MBL of doubled chains that are bent more than 90 degrees around connection points should be reduced as indicated below:

  a) Point with diameter equal to or less than 2 times (1.5 times if the bend is 90 degrees or less) the chain pitch (inside length of links): 50%.
  b) Point with diameter equal to or greater than 4 times (3 times if the bend is 90 degrees or less) the chain pitch: 10% (skew load between the two legs included).
  c) Point with diameter greater than 2 (1.5) times and less than 4 (3) times the chain pitch: linearly between a) and b) above.

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6.2.4.6 Chain binders, ratchets or turnbuckles shall be adequately tensioned before departure and secured so that they cannot become slack.

Guidance note:

If synthetic webbing ratchet straps are used, then:

a) D-links and shackles should be used instead of hooks (which can unhook).
b) The straps should be in good condition, with no rips or abrasion damage. They should not have been, or be likely to be, subject to chemical degradation or excessive sunlight (ultraviolet radiation). Note that different types of synthetic materials (e.g. nylon and polyester) have very different resistances to acids, alkalis, UV radiation, ripping and abrasion.
c) There should be no sharp edges to damage the straps, see also [6.2.4.5] above. If sharp edges are avoided by adding rubber or something similar, the rubber should be properly secured.
d) The fittings should be of the correct shape and size to ensure that the straps are not damaged.
e) Straps should not be knotted or twisted more than 90 degrees unless otherwise indicated by the certification.

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6.2.4.7 Steel wire and fibre lashings should be inspected regularly and always after bad weather during the transport. Re-tensioning shall be done whenever required.

Guidance note:
The above requirement may be waived if it is properly documented that the lashings fulfil their design intention even if they become slack.

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6.2.4.8 Lashing equipment (chains, wires, shackles, turnbuckles, etc) shall have certificates stating their ultimate capacity (MBL), WLL or SWL.

Guidance note:
Normally a "Certificate of Conformity" from a recognized manufacturer will be adequate. For equipment delivered from other manufacturers and/or for critical non-standard equipment the certificate should be issued or endorsed by a body approved by an IACS member or other recognized certification body.

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6.2.4.9 Certificates should be revalidated at intervals of not more than 4 years and identify the equipment to which they apply.

6.2.4.10 Re-used lashing equipment should be properly inspected before each transport. See also [3.5.10].

6.2.5 Equipment

6.2.5.1 General requirements are given in DNV-OS-H101, Sec.6.

6.3 Operation

6.3.1 Operational aspects

6.3.1.1 General operational requirements are given in [2.3].

Guidance note:
Some of the requirements for towing operations in [4.4] may also be found relevant for ship transports.

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6.3.2 Transport procedure

6.3.2.1 A transport procedure shall be prepared and distributed to key personnel. The master shall be briefed regarding essential information in the transport manual (design limitations, restrictions etc), see also DNV-OS-H101, Sec.4 G200.

6.3.2.2 The transport procedure should contain detailed information regarding the:

- route
- ports/areas of shelter
- estimated transport time, ETD and ETA
- environmental limitations w.r.t. the structural capacity of the object, seafastening, grillage etc.
- contingency actions
- reporting routines for progress, ETA, status, etc.
- cargo and seafastening inspection routines
- contact persons, including key personnel at the receiving site, and telephone numbers.

6.3.3 Inspection

6.3.3.1 The seafastening arrangements and cargo should be inspected during the voyage. See also [6.2.4.7].

6.3.3.2 Inspection procedures describing what, when and how to inspect should be developed. Reporting/recording routines and possible corrective actions should be described.

SECTION 7 HEAVY TRANSPORTS

7.1 General

7.1.1 Application

7.1.1.1 This section applies to objects being transported on heavy transport vessels (HTV).

Guidance note:

Some of the requirements may also be applicable for sea transports on other types of vessels. References to this section in this context have been made where found relevant.

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7.1.2 Planning and documentation

7.1.2.1 Planning and documentation shall comply with [2.1] and [2.2].

Guidance note:

Note that weather routing based on modifying the sailing route and/or speed to avoid "storms" rather than seeking shelter may be found applicable for HTV transports. Thorough risk assessments should be carried out in order to establish adequate design conditions in ULS, ALS and FLS. At least the following should be taken into account:

- Expected and extreme weather conditions in the sailing route, including the possible size, speed and travelling direction of "storms".
- The possibilities for re-routing to avoid "storms" in all parts of the route.
- The risk of "black ship" or HTV needs to sail at reduced speed due to machinery or other problems.
- The transport schedule and (stated) stakeholder acceptance of the transport being delayed.
- A conservative assessment of the applicable sailing speeds in different weather conditions.
- Restrictions in sailing directions due to heading control if applicable.

The transport procedure should duly reflect the assessment and describe necessary actions by the HTV Master.

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7.2 Heavy transport vessel

7.2.1 General

7.2.1.1 General requirements for heavy transport vessel (HTV) are given in DNV-OS-H101, Sec.6 D.

7.2.1.2 All the particulars regarding strength and stability afloat and all systems and equipment should comply with the requirements of the vessel's classification society.

7.2.2 Stability afloat

7.2.2.1 General stability requirements are given in DNV-OS-H101, Sec.5.

7.2.2.2 Adequate stability and spare buoyancy during on- and off-loading shall be documented.

7.2.3 Documentation – heading control

7.2.3.1 If the transport is heading controlled, see [2.1.5] and [7.3.3], the redundancy in the propulsion system shall be adequately documented.

7.3 Design

7.3.1 General

7.3.1.1 See [3.1] general requirements for design basis.

7.3.2 Motions during transit

7.3.2.1 The motions should be determined in accordance with [3.2.1].

7.3.2.2 For HTV transports, the requirements in [3.2.2] shall be especially considered.

7.3.3 Loads and load effects

7.3.3.1 General requirements for loads and load effects are given in [3.3].

7.3.3.2 Heading-controlled transports shall be analysed for design conditions described in [2.1.5]. ALS design approach and load factors should be selected according to DNV-OS-H102 Sec.5 D200.

7.3.3.3 ULS limiting wave heights for heading-controlled transports shall be established for all wave directions.

7.3.3.4 Cargo hanging over the sides of the HTV shall be particularly considered for:

— wave slamming loads, see [5.5.7]
— uplifting
— drag loads
— influence on motions
— influence on stability.

7.3.3.5 If other vessels such as barges are to be transported by the HTV, relevant contingencies on weight shall be included to account for effects such as residual ballast water, marine growth etc.

7.3.4 Structural design

7.3.4.1 Structural design calculations shall comply with DNV-OS-H102, Sec.5. See also [3.2].

7.3.4.2 The local strength of the transported object and HTV at vertical support points and in way of seafastening shall always be verified.

7.3.5 Seafastening and grillage

7.3.5.1 The seafastening (and grillage if applicable) design shall be documented, see [3.5].

7.3.5.2 The grillage design (height of supports/cribbing) shall take into account any protruding parts (e.g. anodes and spud-cans) on the cargo.

Guidance note:
The clearance should be sufficient to account for deflections (e.g. in cribbing) and inaccuracies in measurements. Normally, at least a nominal clearance of 0.075 m should be provided between the lowest protrusion of the cargo and the deck of the barge or vessel.

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7.3.5.3 Design loading on the seafastening may be reduced by considering relevant friction effects on the cribbing, see [7.3.6].

7.3.5.4 As a precaution and to prevent the cargo from shifting due to forces and/or vibrations introduced by hull beam deflection, a minimum seafastening shall be installed.

Guidance note:
If there are no detailed calculations, the minimum seafastening without considering friction for the indicated characteristic accelerations in the table below may normally be considered adequate. Note that this is the minimum seafastening to be considered if the (calculated) transport accelerations minus any friction effect give less acceleration/force.

Direction/Weight	W < 1000 t	1000 t ≤ W < 5000 t	5000 t ≤ W < 20000 t	20000 t ≤ W < 40000 t	W ≥ 40000 t
Transverse	0.15 g	Linear	0.10 g	Linear	0.05 g
Longitudinal	0.10 g	Linear	0.05 g	Linear	0.03 g

Waiving the minimum seafastening requirement may be considered if the effect of vibrations and hull beam deflections could be proven to be insignificant.

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7.3.6 Cribbing

7.3.6.1 The maximum cribbing loads shall be calculated. Static and dynamic loads in addition to global deflections of the cargo and vessel shall be considered.

7.3.6.2 The size of the cribbing shall be adequate to account for possible inaccuracies in the positioning of cargo, placement of guides, etc.

7.3.6.3 The placing and width of the cribbing shall be such that no local overloading of the cargo or vessel will occur.

7.3.6.4 The cribbing strength and deformation characteristics shall be adequate for the intended load bearing and load spreading.

7.3.6.5 If not documented otherwise, the dynamic design loading on soft wood cribbing should in ULS be a maximum of 2.0 MPa. Maximum mean loading in an area of 10% of the total cribbing area may be considered.

Guidance note:

A higher dynamic loading may be acceptable, but it should then be documented that redistribution of loading is possible, considering the cargo design loading - including the overturning moment and a maximum cribbing pressure of 2 MPa. If excessive deformation in the cribbing is acceptable, e.g. if there is only a thin layer of soft wood, a higher loading than 2 MPa is normally acceptable.

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7.3.6.6 The friction on the cribbing shall be considered, see DNV-OS-H102, Sec.4 A600. According to DNV-OS-H102, the characteristic friction coefficient shall be documented and a material factor applied to find the design friction coefficient.

Guidance note:

In the areas and directions where the full friction effect could be mobilized a design friction coefficient of 0.3 may normally be applied between the wood and steel in the cargo. Any special effects (e.g. wood treatment, type of cargo surface treatment and risk of oil/lubricant present) that may reduce the friction significantly should be evaluated.

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7.3.6.7 Due to low wood shear stiffness and strength, friction forces transverse to the cribbing (soft wood) boards should only be accounted for if properly documented.

Guidance note:

If no thorough evaluation, including cribbing shear stiffness and seafastening design (stiffness), has been carried out, the following apply:

a) For cribbing with H (height) ≥ 1.5B (breadth), a zero contribution from friction in the transverse cribbing direction should be considered.

b) For cribbing with H < 1.5B, a contribution from friction in the transverse direction may be considered (1.5B – H)/1.5B × 100%.

c) Normally, a 100% contribution from friction may be considered in the longitudinal cribbing direction. However, see [3.5.3.5].

d) The mean design friction coefficient considered should in any case not exceed 0.2, but see [7.3.6.8] below.

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7.3.6.8 If applicable, a reduced vertical load due to the buoyancy of submerged cargo shall be accounted for.

Guidance note:

If there are no detailed calculations (of the buoyancy) effect and a mean design friction coefficient of 0.2 is found applicable according to sections [7.3.6.6] and [7.3.6.7], the design friction coefficients tabulated below may be used. If the overhang is greater than 45m no friction should be assumed for any cargo weight.

Overhang/Weight	W < 5000 t	5000 t ≤ W < 10000 t	10000 t ≤ W < 20000 t	W ≥ 20000 t
< 15 m	0.1	0.2	0.2	0.2
15 – 25 m	0.0	0.1	0.2	0.2
25 – 35 m	0.0	0.0	0.1	0.2
35 – 45 m	0.0	0.0	0.0	0.1

For cargoes that weigh less than 1000 t and/or have unusually high potential buoyancy, the possible effect of buoyancy (and green water, see [3.3.3]) should always be evaluated on a case-by-case basis.

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7.4 Loading and off-loading

7.4.1 General and application

7.4.1.1 HTVs are normally loaded in a float-on operation or a loadout. Loadout requirements are given in DNV-OS-H201, Sec.3.

7.4.1.2 DNV-OS-H201, Sec.7 C covers inshore docking, which in general is applicable for HTV float-on operations. Some complementary requirements relevant for float-on and float-off from HTV are given in this sub-section. The requirements generally apply to float-off operations as well.

7.4.2 Cargo supports

7.4.2.1 The design of the supports shall take into account possible horizontal loads during the positioning of the cargo.

7.4.2.2 Wood cribbing (and other “floating materials”) shall be properly secured to counteract buoyancy forces.

7.4.2.3 Drawing(s) of the cargo support (e.g. cribbing) lay-out shall be made and both horizontal and vertical position tolerances shall be defined.

7.4.3 Positioning and guides

7.4.3.1 A primary positioning system (normally tugs) should be capable of ensuring safe navigation and the positioning of the object close to the HTV, where the secondary positioning system could be connected.

7.4.3.2 The secondary positioning system should ensure the accurate and well-controlled positioning of the object above the HTV.

Guidance note:

It should be documented that the positioning could take place without unintended contact with the HTV including any items on the HTV deck, and without loads exceeding the capability of positioning guides. Environmental effects should be considered. Varying wind and current may be of especially significant importance.

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7.4.3.3 The sufficient capacity of the secondary positioning system (normally winches) should be documented.

Guidance note:

It is not recommended to include tugs in the secondary positioning system so the pull/push force from tugs should not be included in the capacity check.

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7.4.3.4 The guide posts shall be designed both to withstand maximum loads imposed by winch line loads etc. and to absorb a relevant amount of energy. See DNV-OS-H101, Sec.6 C for guidance.

7.4.3.5 A conservatively assessed/calculated design load shall be applied for non-redundant (see [7.4.3.7]) guide posts.

7.4.3.6 The guide posts should normally extend 2 metres above the water plane at the deepest draught. The guide post shall be clearly visible during the float-on/float-off operations.

7.4.3.7 Adequate redundancy and/or contingency procedures covering single failure(s) in the position system should be considered.

7.4.4 Ballasting and stability

7.4.4.1 General ballast system requirements are given in DNV-OS-H201, Sec.2 B.

7.4.4.2 Step-by-step ballast calculations, including stability verifications shall be presented.

7.5 Operational aspects

7.5.1 General

7.5.1.1 General operational requirements are given in [2.3].

7.5.2 Transport procedure

7.5.2.1 A transport procedure shall be prepared and distributed to key personnel. The master shall be briefed about essential information in the transport manual (limitations, restrictions etc), see also DNV-OS-H101, Sec.4 G200.

7.5.2.2 The transport procedure should contain detailed information regarding the:

— load-on/load-off locations
— route
— ports/areas of shelter
— estimated transport time, ETD and ETA
— environmental limitations w.r.t. the structural capacity of the object, seafastening, grillage etc
— contingency actions
— reporting routines for progress, ETA, status, etc
— contact persons and telephone numbers
— expected environmental conditions for the intended route for the relevant season
— procedures, including procedures during departure and arrival as well as calls at intermediate ports.

7.5.3 Float-on and float-off

7.5.3.1 The float-on/off shall be carried out at locations where the limiting loading criteria are (easily) obtainable and with adequate bottom clearance in a sufficient area for adequate manoeuvring of the HTV and transported object.

Guidance note:

If the spare buoyancy of the HTV is considered critical, a location with depth and bottom conditions that could allow the HTV to be supported at the bottom as a contingency is recommended.

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7.5.3.2 A detailed operation procedure should be prepared for the float-on and float-off.

7.5.3.3 Limiting environmental criteria shall be established for the float-on /float-off operation.

Guidance note:

Normally the limiting criteria should be insignificant current, maximum waves/motions as indicated in DNV-OS-H201, Sec.7 C400 and a maximum wind speed of 15 knots.

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7.5.3.4 The documented minimum nominal clearance between the cargo and top of the cribbing should be 0.5 metres during float-on/float-off. If the effect on the clearance of motions, tolerances and deflections could be significant, the minimum tolerance should be increased accordingly.

Guidance note:

All possible relative horizontal positions of the object and HTV during float-on/off should be considered. Any protruding elements on the object and HTV deck should be accounted for.

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7.5.4 Inspections and testing

7.5.4.1 A survey of the loading/unloading site should be performed to ensure a sufficient water depth during the loading/unloading operation.

7.5.4.2 It shall be confirmed by survey that all supports (cribbing) and guide posts are correctly positioned (and secured) within defined horizontal and vertical tolerances.

7.5.4.3 The cargo and seafastening should be inspected daily during the voyage.