OFFSHORE STANDARD

DNV-OS-H201

Load Transfer Operations

APRIL 2012

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

DET NORSKE VERITAS AS

FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

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

© Det Norske Veritas AS April 2012

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

This service document has been prepared based on available knowledge, technology and/or information at the time of issuance of this document, and is believed to reflect the best of contemporary technology. The use of this document by others than DNV is at the user's sole risk. DNV does not accept any liability or responsibility for loss or damages resulting from any use of this document.

CHANGES

General

This is a new document in a series of documents replacing "Rules for Planning and Execution of Marine Operations" (1996/2000).

This Standard replaces Pt.2 Ch.1 in the referred Rules. Nearly all parts of the text have been considerably updated with the following main changes:

— The requirements relevant for all types of load transfer operations have been gathered in a new section: "Sec.2 - General Requirements".
— A new section: "Sec.7 - Other Load Transfer Operations" that e.g. includes requirements to offshore float-over operations, has been included.

CONTENTS

Sec. 1 Introduction 8

A. Application 8
A 100 General 8
A 200 Complementary standards 8
A 300 Objectives and conditions 8

B. References 8
B 100 Referenced Documents 8

C. Definitions 9
C 100 Verbal forms 9
C 200 Terminology 9
C 300 Symbols 10

Sec. 2 General Requirements 11

A. Design Phase 11
A 100 Planning 11
A 200 Loads and design 11
A 300 Risk management 11

B. Ballasting Systems 11
B 100 General 11
B 200 Operation class 11
B 300 Ballast system lay-out and reliability 12
B 400 Tank capacity 12
B 500 Ballasting capacity 13
B 600 Strength considerations 13
B 700 Ballasting control 13
B 800 Ballast calculations 14
B 900 Contingency and back-up 14

C. Documentation 15
C 100 General 15
C 200 Design documentation 15
C 300 Equipment, fabrication and vessel(s) 15
C 400 Operation manual 15

D. Operational Aspects 15
D 100 General 15
D 200 Preparations 16
D 300 Clearances 16
D 400 Recording and monitoring 16
D 500 Environmental effects 16
D 600 Marine traffic 16
D 700 Organisation and personnel 16

Sec. 3 Loadout 18

A. General 18
A 100 Application 18
A 200 Loadout class 18
A 300 Planning and design 18

B. Loads 19
B 100 General 19
B 200 Weight and CoG 19
B 300 Weight of loadout equipment 19
B 400 Environmental loads 19
B 500 Skidding loads 19
B 600 Skew load 20
B 700 Other loads 20

C. Design Calculations 20
C 100 General 20
C 200 Load cases 20
C 300 Quays 21
C 400 Soil 21

D. Systems and Equipment 21
D 100 General 21

D 200 Push/pull systems 21
D 300 Trailers 22
D 400 Skidding equipment 23
D 500 Ballasting systems 23
D 600 Power supply 24
D 700 Testing 24
D 800 Mooring and fendering 24

E. Vessel(s) 25
E 100 General 25
E 200 Structural strength 25
E 300 Stability afloat 25
E 400 Loadout vessel draught and motions 26
E 500 Maintenance 26

F. Operational Aspects 26
F 100 General 26
F 200 Loadout site 26
F 300 Supports and skidways 26
F 400 Grillage and seafastening 27
F 500 Monitoring 27

G. Special Cases 27
G 100 Grounded loadouts 27
G 200 Transverse barge loadouts 28
G 300 Load-in 28
G 400 Vessel to vessel load transfer 28

Sec. 4 Float-out 29

A. General 29
A 100 Application 29
A 200 Planning and design basis 29
A 300 Documentation 29

B. Loads 29
B 100 General 29
B 200 Weight 29
B 300 Buoyancy 29
B 400 Other loads 29

C. Load Effects and Analyses 29
C 100 General 29
C 200 Load cases 29
C 300 Structures 30
C 400 Stability afloat 30

D. Systems and Equipment 30
D 100 General 30
D 200 Installation systems 30
D 300 Air cushion systems 30
D 400 Mooring, Positioning and Towing system 30

E. Operational Aspects 30
E 100 General 30
E 200 Clearances 31
E 300 Monitoring 31

Sec. 5 Lift-off 32

A. General 32
A 100 Application 32
A 200 Lift-off class 32
A 300 Planning and design basis 32
A 400 Documentation 32

B. Loads 32
B 100 General 32
B 200 Weight and CoG 33
B 300 Environmental loads 33
B 400 Skew loads 33
B 500 Other loads 33

C. Load Effects and Analyses 33
C 100 Load effects and load cases 33
C 200 Calculations and analysis 33

D. Structures 34
D 100 General 34
D 200 Object 34
D 300 Construction supports 34
D 400 Vessel supports 34

E. Systems and Equipment 34
E 100 General 34
E 200 Ballasting systems 34
E 300 Positioning systems 34

F. Lift-off vessel(s) 35
F 100 General 35
F 200 Structural strength 35
F 300 Stability afloat 35

G. Operational Aspects 35
G 100 General 35
G 200 Lift-off site 35
G 300 Preparations 35
G 400 Clearances 35
G 500 Monitoring and monitoring systems 36

Sec. 6 Mating 37

A. General 37
A 100 Application 37
A 200 Planning and design basis 37
A 300 Documentation 37

B. Loads 37
B 100 General 37
B 200 Skew loads 37

C. Load Effects and Analyses 37
C 100 Basic load cases and force distribution 37
C 200 Additional load cases 38
C 300 Object horizontal restraint 38

D. Structures 38
D 100 General 38
D 200 Vessel supports 38
D 300 Substructure 38

E. Systems and Equipment 39
E 100 General 39
E 200 Vessel(s) ballast system(s) 39
E 300 Substructure ballasting systems 39
E 400 Secondary positioning system 40

F. Operational Aspects 40
F 100 General 40
F 200 Mating site 40
F 300 Preparations 41
F 400 Clearances 41
F 500 Monitoring and monitoring systems 41

Sec. 7 Other Load Transfer Operations 43

A. General 43
A 100 Introduction 43
A 200 Application 43
A 300 Operation class 43
A 400 Ballasting systems 43
A 500 Positioning systems 43

B. Float-over 44
B 100 General 44
B 200 Planning of offshore float-over 44
B 300 Analysis and structures 44
B 400 Systems 44
B 500 Operational aspects 45

C. Inshore Docking 45
C 100 General 45
C 200 Under bottom supports 45

C 300 Positioning and guidance system(s) 45
C 400 Operational aspects 45

Sec. 8 Construction Afloat 46

A. General 46
A 100 Application 46
A 200 Planning and design basis 46

B. Loads 46
B 100 General 46

C. Stability Afloat 46
C 100 General 46
C 200 Inclining tests 46

D. Mooring 47
D 100 General 47
D 200 Anchor lines 47
D 300 Auxiliary anchoring equipment 47

E. Operational Aspects 47
E 100 General 47

SECTION 1
INTRODUCTION

A. Application

A 100 General

101 This standard DNV-OS-H201 gives specific requirements and recommendations for marine operations involving load transfer without use of cranes, i.e. by use of (de-)ballasting. Typical load transfer operations are loadout, float-out, lift-off and mating.

102 This standard also applies for construction afloat phases.

103 Requirements generally applicable for load transfer operations are given in Section 2. Section 3 to Section 8 include requirements for the different types of operations.

104 The requirements in this standard are, as found relevant, applicable also for load transfer operations not specifically mentioned.

A 200 Complementary standards

201 All the DNV offshore standards covering marine operation, i.e. this standard (DNV-OS-H201), DNV-OS-H101, DNV-OS-H102 and DNV-OS-H202 to DNV-OS-H206, will be referred to as the VMO Standard.

Guidance note:

The "VMO Standard" is substituting "DNV - Rules for Planning and Execution of Marine Operations". See also Table 1-1.

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

202 General recommendations for planning, loads and design of marine operations are given in DNV-OS-H101 and DNV-OS-H102.

203 For load transfer operations carried out by crane lifting, reference is made to DNV-OS-H205.

204 The towing aspects of load transfer operations are covered in DNV-OS-H202.

A 300 Objectives and conditions

301 The objectives of this Standard are stated in DNV-OS-H101, Section 1 A.

302 The general conditions for use of this Standard are stated in DNV-OS-H101, Section 1 B200.

B. References

B 100 Referenced Documents

101 For the OS numbering system and cross references, see DNV-OS H101, Sec.1 C101 and C102.

102 The text in this standard includes references to the documents listed in Table 1-1. If indicated where the reference is given, the text in the referenced service document shall be considered as a requirement of this standard.

Table 1-1 References including requirements

Reference	*Revision*	*Title*
DNV-OS-H101	Oct. 2011	Marine Operations, General
DNV-OS-H102	Jan. 2012	Marine Operations, Loads and Design
DNV-OS-H202	See note	Sea Transports
DNV-OS-H203	Feb. 2012	Transit and Positioning of Mobile Offshore Units

Note:
The DNV-OS H-series are planned issued in the period October 2011 to June 2012.
Each OS will enter into force at the date of publication.
Until the OS is published the relevant requirements in "DNV - Rules for Planning and Execution of Marine Operations" shall be considered governing

103 The referred requirements are based on the document revisions indicated in Table 1-1. Any modifications of the referred requirements in later revisions of references shall be considered and normally used unless otherwise agreed.

Guidance note:
The agreement should be made between involved (normally through contracts) parties as Company, Contractors and MWS.

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

104 The documents listed in Table 1-2 include information that through references in this text, clarify and indicate acceptable methods of fulfilling the requirements given in this standard.

105 The latest revision of the informative references should normally be considered.

Table 1-2 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-H104	Ballast, Stability, and Watertight Integrity - Planning and Operating Guidance
DNV Ship Rules	Rules for Classification of Ships
DNV-OS-E302	Offshore Mooring Chain
DNV-OS-E304	Offshore Mooring Steel Wire Ropes
DNV-OS-E301	Positioning Mooring
EN 1997 Eurocode 7	Geotechnical Design

C. Definitions

C 100 Verbal forms

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

Shall: Indicates a mandatory requirement to be followed for fulfilment or compliance with the present standard. Deviations are not permitted unless formally and rigorously justified, and accepted by all relevant contracting parties.

102 *Should:* Indicates 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. Other possibilities may be applied subject to agreement.

C 200 Terminology

201 Terms of special importance are defined as indicated below in this standard.

Docking: The activities necessary to accurately position a self-floating object or vessel (barge) on supports prepared at the seabed (e.g. in a dry dock) or on the submerged deck of a vessel (e.g. HLV/floating dock).

Float-out: The activities necessary to transfer an object from a dry construction site to a self-floating condition outside the construction site.

Float-over: A reversed lift-off. I.e. the activities necessary to transfer a vessel transported object onto land/ seabed supports by a vertical movement.

Lift-off: The activities necessary to transfer, by a vertical movement, the weight of an object from land or seabed supports to supports placed on one or more vessel(s).

Lift-off vessel: Term used for the transport vessel in a lift-off operation.

Load-in: The activities necessary to transfer an object from a vessel to land, i.e. a reversed loadout.

Loadout: The activities necessary to transfer an object from a safe condition on land to a safe condition on a vessel by a horizontal movement of the object.

Loadout vessel: Term used for the transport vessel in a loadout operation.

Load transfer: The activities necessary to transfer an object from one support condition to another.

Mating: The activities necessary to transfer an object, e.g. topside, supported by barges, pontoons, etc. to a floating substructure.

Object: Structure subjected to one or several of the operations defined in this paragraph.

Recognised standard/code: A standard/code that is commonly used and normally found acceptable by the industry.

Safe condition: A condition where the object is considered exposed to normal risk for damage or loss. (See also DNV-OS-H101)

Site move: The activities necessary to transfer an object from one location at the yard to another.

Transport vessel: The vessel (normally barge) that will transport the object to or from the load transfer operation.

Vessel: Barge, ship, tug, mobile offshore unit, crane vessel or other vessel involved in the marine operation. In this standard the term "vessel" will normally refer to the "transport vessel".

VMO (VERITAS Marine Operations): The unit(s) within Det Norske Veritas providing marine warranty survey and marine advisory services.

VMO Standard: All the DNV offshore standards covering marine operation, i.e. DNV-OS-H101, DNV-OS-H102 and DNV-OS-H201 to DNV-OS-H206.

Under bottom supports: Supports (e.g. pads on the seabed or wood cribbing or other types of supports made on a floating vessel) that (the bottom of) a floating object will be supported by after a docking operation is completed.

C 300 Symbols

301 The list below defines the symbols used in this standard:

ALS Accidental Limit State
CoB Centre of buoyancy
CoG Centre of gravity
F_{dyn} Expected dynamic skidding load
F_s Expected static skidding load
f_{min} Minimum effective freeboard
g Gravitational acceleration
GBS Gravity Base Structure
GM Initial metacentric height
H_{max} Maximum anticipated wave height
HLV Heavy Lift Vessel
NDE Non-destructive Examination
P_{dyn} Additional loads during skidding
P_s Additional break loose loads during skidding
T_{POP} Planned operational period
T_R Operation Reference Period, see DNV-OS-H101 Section 4 B.
W Weight (of object)
W_{eq} Weight of loadout equipment
μ_{dyn} Dynamic friction coefficient
μ_s Static friction coefficient

SECTION 2
GENERAL REQUIREMENTS

A. Design Phase

A 100 Planning

101 General requirements to planning are given in DNV-OS-H101, Section 2 A.

102 The required operation reference period, T_R, defined in DNV-OS-H101, Section 4 B, should be thoroughly evaluated at an early stage.

103 The start and end points for load transfer operations shall be safe conditions, and they should be clearly defined.

104 A load transfer operation could exist of several sub-operations. This shall be thoroughly considered in the overall planning of the operation.

Guidance note:

E.g. a loadout from one safe to another safe condition (see DNV-OS-H101, Section 2 A102) could include "lift-off from construction supports", "site move", "move onto barge", "temporary seafastening phase", "turning of barge" and "final mooring of barge". In such a case it should be considered to define (and design for) additional safe conditions in order to shorten the required weather window(s).

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

105 A load transfer operation could involve various construction-, transport- and load transfer (main) contractors/responsible. This should be duly considered in the interface planning.

106 All possible environmental conditions, see DNV-OS-H101, Section 3, shall be evaluated and considered in the planning (and design).

107 The (sub-) operation(s) should be defined as either weather restricted or unrestricted, see DNV-OS-H101, Section 4 B.

A 200 Loads and design

201 Loads and load effects are generally defined in DNV-OS-H102. It shall be thoroughly evaluated if any other loads and load effects not described in DNV-OS-H102 need to be considered.

202 The design principles and methods described in DNV-OS-H102 shall be adhered to.

203 All relevant limit states as defined in DNV-OS-H102 shall be included in the design calculations/ analysis.

A 300 Risk management

301 Operational risk should be evaluated and handled in a systematic way. See DNV-OS-H101, Section 2 C.

B. Ballasting Systems

B 100 General

101 This sub-section is mainly applicable for ballasting and de-ballasting of vessel(s) involved in load transfer operations. See Section 6 E300 regarding (de-)ballasting of substructures.

102 The (de)ballasting system design shall properly consider the operation class (see B200) as well as functional requirements related to:

— lay-out and reliability of the system
— tank capacities including contingency situations
— ballasting capacity including contingency situations
— strength limitations
— easy controllable ballasting.

103 General requirements to (de)ballasting systems are given in DNV-OS-H101, Section 6 A.

104 Requirements to power supply and testing of ballast system are given in Section 3 D600 Section 3 D700.

B 200 Operation class

201 An operation class should be defined for load transfer operations covered by Table 3-1 (loadout), Table 5-1 (lift-off) and Table 7-1 (other operations).

B 300 Ballast system lay-out and reliability

301 The ballast pumps may be the vessel's own pumps, pumps purposely installed for the load transfer, or a combination of these.

302 To rely on barge internal pumps as the primary pumping means should be carefully considered, bearing in mind the often unreliable service record and the inherent inflexibility of the permanent piping systems.

303 Ballasting by flooding (i.e. opening of bottom valves) and/or de-ballasting by air pressurising ballast tanks should normally be avoided, at least during load transfer phases where accurate control of the ballast amount is crucial.

Guidance note:

Ballasting by flooding during load transfer phases where accurate control of ballast amount is crucial may be allowed if the system has sufficient redundancy (e.g. double valves to compensate a failure to close a valve) and/or backup ballast plans are available where mechanical failures can be compensated by an alternative ballast procedure.

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

304 Umbilicals used for air pressurisation of submerged barge compartments should be connected to valves at the barge tanks.

305 Air pressurised barge tanks should be fitted with safety valves.

306 Hoses, umbilicals and power cables should be placed with due consideration to other ongoing activities during the load transfer.

307 Required access throughout the load transfer for (possibly) needed equipment as e.g. fork lifts for replacing pumps should be demonstrated.

308 Back-up systems should be adequately separated from the main system such that failure of any component does not adversely affect the safe conduct of the operation.

B 400 Tank capacity

401 The ballast tanks shall have adequate capacity to make it feasible to maintain the vessel at required (see e.g. Section 3 F401) level (draughts), trim and heel throughout the load transfer operation.

402 The requirement in 401 above applies for both the planned ballasting sequence as well as for all relevant contingency situations, see Table 2-1.

403 A reasonable amount of residual water in the tanks should be taken into account.

Guidance note:

The amount to be considered will depend on details- and placing of the pumping intake(s), heel/trim of the vessel and structural elements at the tank bottom. For tanks in use during the load transfer the minimum water head should normally be taken equal to the height of the tank bottom stiffeners added 0.05 meters.

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

404 The required tank capacities should include relevant spare capacity for e.g. to compensate the following:

a) Tide levels below or above the predicted values. See also Section 3 A302

b) Vessel lightweight, including installed equipment, grillages, etc., higher or lower than expected

c) Possible object weight and CoG variations.

Table 2-1 Tank capacity requirements

Operation Class	*The tank capacity shall be adequate for the following scenarios in addition to the normal operation:*
1	Reversing of the operation. Tide compensation if stop in load transfer, considering maximum possible (defined) duration of the load transfer. See notes below.
2	Ballasting through a complete tide cycle at any stage of the load transfer. Maximum tide variations within the operation period (T_R) shall be considered. Reversing of the operation. See notes below.
3	Ballasting through a complete tide cycle at any stage of the load transfer. Maximum tide variations for at least the coming 3-5 days shall be considered. See notes below.
4	Reversing of the operation. See notes below.
5	See notes below.

Notes:

a) Spare tank capacity to cover items 403, 404 and 404 shall be ensured in all situations.

b) Any considered pumping capacity contingency involving modifications in ballasting procedures shall be considered. See Table 2-2, Note d).

B 500 Ballasting capacity

501 The ballasting capacity shall be adequate to maintain the vessel at required level, trim and heel throughout the load transfer operation.

Guidance note:

Adequate capacity shall be documented considering the requirements to nominal-, spare- and back-up capacity given in this sub-section.

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

502 The nominal ballasting capacity shall be determined by the worst combination of expected tide rise/fall and planned load transfer velocity. (See Section 3 D204).

503 For operation classes 2 and 3, it shall be documented that the ballast systems have capacity to compensate for the tide rise/fall through one complete tide cycle with the loadout object in any position.

Guidance note:

If the tide variations are increasing the coming days after the planned operation start this should be considered in the evaluations in order to cover for a possibly delayed start and/or serious delays during the operation. See also Table 2-1.

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

504 Spare pumps should normally be installed and tested in the position they are planned used as back-up. However, for pumps that may be replaced during the operation spare pumps in stand-by position that require a minimum of time for replacement may be used. Required number of spare pumps should be conservatively assessed. The replacement time shall be documented. See also 307.

505 Requirements for minimum total ballasting capacity, including back-up, are given in Table 2-2. See also notes in the table.

Table 2-2 Ballasting capacity requirements

Operation Class	*Normal Operation Load transfer as planned*	*Tide Compensation Load transfer unexpectedly stopped*
1	Minimum 200% capacity with intact system and minimum 120% capacity in all tanks with any one pump system failed.	Minimum 120% capacity with intact system and minimum 100% capacity in all tanks with any one pump system failed.
2	Minimum 130% capacity with intact system and minimum 100% capacity in all tanks with any one pump system failed.	Minimum 150% capacity with intact system and minimum 120% capacity in all tanks with any one pump system failed.
3	Minimum 130% capacity with intact system and a contingency plan covering pump system failure.	As for Class 2
4	As for Class 2	No requirements
5	As for Class 3	No requirements

Notes:

a) 100% pump capacity during normal operation is the capacity required to carry out the operation at the planned speed. The required pump capacity for a reduced speed could be acceptable as reference, if ballast calculations are presented for this case. The maximum allowable operation period should also be duly considered.

b) 100% pump capacity during tide compensation is the capacity required to compensate for the maximum expected tide velocity.

c) A pump system includes the pump(s) which will cease to operate due to a single failure in any component.

d) The back-up requirement X% capacity in all tanks could be covered by a modified ballast procedure giving X% capacity in all tanks involved in this modified procedure.

e) Operation classes are defined in 201.

B 600 Strength considerations

601 Any hull beam strength limitations, see Section 3 E201, should be considered in the ballast procedure.

602 The effect of hull beam deflections on the object support load distribution shall be considered, see DNV-OS-H102, Section 4 A800.

603 Any restrictions, e.g. any requirement to mimic the vessel transport condition, on ballast condition(s) during welding of seafastening shall be considered. See DNV-OS-H202.

604 Possible significant strength reduction due to cut outs, etc. for ballast hoses, -pumps or other equipment in structural elements should be considered.

B 700 Ballasting control

701 A straightforward ballasting control system and procedure shall be used.

Guidance note:

It is recommended that it is possible to operate the ballast pumps from one control centre during operation. For multi barge operations a control centre on each barge may be applicable. However, the control centre at one of the barges should be defined as the master ballast control centre. The arrangement should be such that simultaneous de-ballasting can be effected for all the relevant tanks at each stage.

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

702 It shall be thoroughly documented how the ballasting will be done (controlled) for all possible combinations of tide level and load transferred.

Guidance note:

In order to maintain maximum control with the ballasting it could be advisable to use separate systems/tanks for compensation of the effects of tide variation, weight transferred, and CoG position in both directions (trim and heel). To use a system/tank for compensation of more than two effects shall be avoided.

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

703 A proper ballasting control monitoring system including back-up shall be established. See also C.402 b) and D 400.

B 800 Ballast calculations

801 Ballast calculations shall be carried out in order to establish required nominal (i.e. the 100%, see the Table 2-2, capacity) pumping capacities.

802 For ballast calculations the expected CoG and weight without any contingencies should normally be used as the base case. However, the effect of possible weight and CoG variations shall be considered, see Section 3 B204.

803 The ballast calculations shall include sufficient steps to accurately define the required ballasting throughout the load transfer operation.

804 All considered contingency situations should also be covered with an adequate number of ballast calculation steps.

805 The results of the ballast calculations, i.e. required pumping in all steps, shall be clearly outlined in ballast procedure(s).

B 900 Contingency and back-up

901 Means for adequate handling of all ballast system contingencies identified in the risk management process shall be provided.

902 The contingencies indicated in Table 2-3 shall be considered. Minimum requirements to back-up have also been indicated.

Table 2-3 Recommended Contingency requirements

No	*Contingency situation*	*Recommended back-up*
1	Tidal velocities above (or below) the predicted values.	Spare pump(s) or spare capacity in the main pump(s). See Table 2-2 for specific requirements.
2	Unplanned stops in load transfer (e.g. object movement stopped due to repair work, etc.)	Adequate tank and pump capacities to handle the situation. See Table 2-1 and Table 2-2 for specific requirements.
3	Reversing of operation, if required.	Ballast procedures/calculations with corresponding pump lay-out and tank capacities for this case shall be available.
4	Reduced pump capacity.	Spare pump capacity. See Table 2-2 for specific requirements in %.
5	Breakdown of ballast pump(s).	Spare pump(s) or spare capacity in the main pump(s). See Table 2-2 for specific requirements.
6	Breakdown of power supply, including cables.	Back-up required, see Section 3 D602, or adequate pump capacity, see Table 2-2, considering any power supply unit failed shall be documented.
7	Failure of any control panel/switchboard.	Sufficient back-up to fulfil the requirements in Table 2-2 for one pump system failed. Alternative pump/valve control methods (locations and procedures) could also be accepted as back-up.
8	Failure of any ballast valve or hose/pipe.	

C. Documentation

C 100 General

101 General requirements to documentation are given in DNV-OS-H101, Section 2 B.

102 General requirements to documentation on site are given in DNV-OS-H101, Section 4 G.

Guidance note:

For operations with T_R > 24 hours a proper system for handling changes to documents/procedures in the operation phase should normally be applied.

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

C 200 Design documentation

201 The following design documentation is normally required:

— Analyses/calculations/certificates/statements adequately documenting the necessary strength and capacity of all involved equipment and structures.
— Documentation of civil elements (soil, quay, bollards, etc.) by e.g. engineering calculations, approved drawings or certificates.
— Vessel (barge) stability and (local) strength verifications (see also 302, 302).
— Ballast calculations covering the planned operation as well as contingency situations.

202 Evaluations and calculations of expected monitoring results should be presented. Acceptable tolerances should be stated and documented.

C 300 Equipment, fabrication and vessel(s)

301 Acceptable condition of equipment, fabrication and vessel(s) shall be documented by:

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

for all structures, equipment and vessel(s) involved.

302 For vessel that will be (de)ballasted during the operations the following documentation should at least be presented:

— general arrangement drawing
— hull structural drawings, including any internal reinforcement
— limitations for evenly distributed load and point loads on barge deck
— equipment data and drawings
— hydrostatic data presented in curves/tables
— tank plan, including ullage (or sounding) tables
— guidelines for air pressurised barge tanks, if used
— guidelines, if applicable, for grounded barge condition.

C 400 Operation manual

401 An operation manual shall be prepared, see DNV-OS-H101, Section 4 G.

402 The items listed below will normally be essential for a successful execution of the load transfer operations and shall be emphasized in the manual:

a) A detailed operational communication chart (and/or description) showing clearly the information flow throughout the operation.

b) Monitoring procedures describing equipment set-up, recording, expected readings including acceptable deviations and reporting routines during the operation.

c) Detailed ballast procedures, see B805.

D. Operational Aspects

D 100 General

101 The general requirements to planning and execution of the operation in DNV-OS-H101 Section 4 apply.

Guidance note:

The following paragraphs include some additional requirements and/or emphasise on requirements considered especially important for load transfer operations.

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

D 200 Preparations

201 All structures and equipment necessary for the operation shall be correctly rigged and ready to be used.

202 It should be ensured that means (e.g. steel plates) and personnel (e.g. welders) for general repair work will be available during the operations.

203 For operations or phases of operations that may be carried out in darkness sufficient lighting shall be arranged and be available during the entire operation.

D 300 Clearances

301 Adequate minimum clearances, including clearances under water, for all phases of the load transfer operation shall be defined and properly documented by calculations and surveys before and during the operation.

Guidance note:

More detailed requirements to clearances and type of surveys are indicated in for each type of load transfer operation in sections 3 to 7. Welding/erection of "last minute" items should not be allowed without a proper re-check of the clearances.

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

302 The involved land area and searoom shall be checked for obstacles. All obstacles that could cause damages and/or which may unduly delay the operation shall be removed.

303 If relevant, adequate tug air draft shall be ensured.

Guidance note:

The nominal air draft should be minimum 0.5 metres. All positions, including needed access routes, that mat be required for the tug(s) should be considered. Possible emergency situations should be included in the considerations.

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

D 400 Recording and monitoring

401 During the operation a detailed log should be prepared and kept, see DNV-OS-H101 Section 4 G300.

402 Monitoring shall be carried out according to DNV-OS-H101, Section 4 D.

D 500 Environmental effects

501 Effects caused by (unexpected) swell and tide could be of significant importance for load transfer operations and shall be duly considered.

D 600 Marine traffic

601 In areas with other marine traffic necessary precautions to avoid possible collisions (e.g. with the object, involved vessel(s) or mooring lines) should be taken.

602 Possible significant waves from passing vessel(s) should be prevented.

Guidance note:

If required local harbour authorities should be requested to put restrictions on the marine traffic.

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

D 700 Organisation and personnel

701 General requirements to organisation, personnel qualifications and communication are given in DNV-OS-H101, Section 4 E.

Guidance note:

Load transfer operations will in many cases involve personnel which are not participating in this type of operation on a frequent basis. Personnel exercising and briefing are hence of great importance, see DNV-OS-H101, Section 4 E300.

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

702 Load transfer operations may involve rather complicated equipment. Hence, it should be ensured that equipment operators have the required experience. See e.g. Section 3 E502.

703 Proper working conditions for personnel shall be ensured throughout the load transfer operation.

Guidance note:

Load transfer operations may last for many hours or sometimes for several days and they may be carried out in areas with limited permanent facilities. Hence, the following may be important to consider:

— In order to allow for proper continues work execution easy access to food, drinking water and toilets should be arranged.
— Adequately sheltered/heated/cooled working location(s) for required paper/PC work during the operation.
— Safe access to all areas were work, including inspections, may be required should be ensured.

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

SECTION 3
LOADOUT

A. General

A 100 Application

101 This section applies for transfer of heavy objects from land onto a transport vessel (normally a barge), i.e. loadouts. Loadouts may be carried out by moving the object onto the transport vessel in the longitudinal or transverse direction of the vessel. All the given requirements are valid for any object moving direction, but some items of special importance for transverse loadouts are given in Section 3 G200.

102 As applicable this section applies also for site moves. Site moves may be defined as loadout Class 4 or 5, see A200.

103 Load-in and barge (vessel) to barge (vessel) load transfer operations are generally covered by this section. Special requirements for such operations are given in G 200 and G 400.

104 Special considerations for grounded loadouts are listed in G 100.

A 200 Loadout class

201 Requirements to loadout equipment are defined according to loadout classes. The loadout shall, based on tide conditions, restrictions regarding weather and repair possibilities be classified according to Table 3-1.

Table 3-1 Loadout class definition

Tide range	*Tide restrictions*	*Weather restrictions*	*Loadout Class*
Significant	Yes	No/Yes	1
Significant	No	Yes	2
Significant	No	No	3
Zero	No	Yes	4
Zero	No	No	5

Notes

— A significant tide range indicates that ballasting is required to compensate for the tide variations. If no tide ballasting is required the range is defined as zero.
— If the ballast system cannot compensate for a complete tide cycle the loadout is defined as tide restricted, i.e. Class 1, see also Section 2 B503.
— Requirements for weather restricted operations are given in DNV-OS-H101, Section 4 B500.

Guidance note:

For grounded loadouts, see G100, the loadout classes 2 to 5 should be defined as follows:

— If ballasting due to tide variations is required to maintain ground reactions within acceptable limits, the loadout shall be defined as class 2 or as class 3 if no weather restrictions apply.
— If no ballasting due to tide variations is necessary to maintain ground reactions within acceptable limits the loadout should be defined as class 4 or as class 5 if no weather restrictions apply.

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

202 Consideration shall be paid to possible water level differences due to environmental effects (see 302). If such effects could be significant during the loadout the tide range should normally be regarded as significant, also if the astronomical tide variation is defined as zero.

A 300 Planning and design

301 General requirements are given in Section 2 A100 and requirements to documentation in Section 2 C.

302 Tide variation, which is normally a critical parameter for loadouts, should be specially evaluated. Extreme tide levels and rates of change due to possible environmental effects should be considered.

303 Other items of importance for planning of loadout operations are:

— yard lay-out, including position of object
— transport vessel dimensions and strength
— object position and support height on transport vessel
— loadout route survey regarding clearances and obstructions
— water depths
— local environmental effects, especially the possibility of waves/swell
— quay strength and condition
— loadout site soil strength and condition.

B. Loads

B 100 General

101 The general requirements to loads and design in Section 2 A200 apply.

B 200 Weight and CoG

201 Weight (W) and CoG of the object shall be determined as described in DNV-OS-H102, Section 3 C.

202 The appropriate weights and CoGs to be used may be evaluated separately for strength and ballast purposes. See Section 2 B802.

203 Any possible CoG position shall be considered for support layouts or systems sensitive to CoG shifts.

204 If there are significant uncertainties regarding weight and CoG position, sensitivity analysis should be carried out. See DNV-OS-H102, Section 4 A200.

B 300 Weight of loadout equipment

301 The weight of the loadout equipment (W_{eq}) should be accurately assessed.

Guidance note:

W_{eq} is the total weight of equipment and support structures which moves with the transported object. Such equipment may be support beams, grillages, skidding shoes, trailers, push/pull jacks, hydraulic power packs, etc.

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

302 Any uncertainties in weight and CoG of loadout equipment shall be considered by applying conservative estimates in the loadout calculations. See however Section 2 B802.

B 400 Environmental loads

401 All load effects caused by tide variations shall be considered.

402 Loadout operations should normally not be carried out in significant waves and swell conditions.

Guidance note:

Applicable loads due to waves and swell for transport vessel mooring before and after the loadout operation to be considered.

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

B 500 Skidding loads

501 The expected static and dynamic skidding loads are respectively the loads required to start and to continue moving the object. These loads are expressed as:

$$F_s = \mu_{ud,s}\,(W+W_{eq}) + P_s$$

$$F_{dyn} = \mu_{ud,dyn}\,(W+W_{eq}) + P_{dyn}$$

where

F_s: Static skidding load
F_{dyn}: Dynamic skidding load
$\mu_{ud,s}$: Static upper bound design friction coefficient, see 504
$\mu_{ud,dyn}$: Dynamic upper bound design friction coefficient, see 504
W: See B 200
W_{eq},: See B 300
P_s: Any other load occurring during break-out, see also 502
P_{dyn}: Any other load occurring during skidding, see also 502.

502 Load effects due to

a) inertial loads
b) environmental loads
c) slope of the skidding or rolling surface

should be considered and if relevant included in the skidding loads.

503 If two or more push/pull systems are used the effect of maximum possible differential push/pull loads shall be considered.

504 The upper bound design friction coefficient values used should not be taken less than specified in Table 3-2 unless adequate in-service documentation indicates that other values may be used. See also DNV-OS-H102, Section 4 A600.

Table 3-2 Upper bound design friction coefficients

Sliding (rolling) Surfaces		*Static*	*Moving*	*Notes*
1	Steel/steel	0.30	0.20	a) It is assumed that the sliding surfaces are properly lubricated. b) Break out factor to account for extra loading due to long term effects such as adhesion, settlements, etc. is included in the static coefficients. c) The values are valid only for contact stresses lower or equal to the allowable contact stresses for the considered medium. Allowable contact stresses should be obtained from the manufacturer or from an applicable code or standard. d) Wood should normally be surface treated by wax or by other adequate means in order to avoid that the lubrication is absorbed by the wood. e) The "friction" in items 7 to 9 is "rolling resistance" and properly compacted gravel is assumed in item 9.
2	Teflon/steel	0.25	0.10	
3	Teflon/stainless steel	0.20	0.07	
4	Teflon/wood (without wax)[d)]	0.40	0.10	
5	Teflon/waxed wood	0.20	0.07	
6	Steel/Waxed wood	0.20	0.12	
7	Steel rollers/steel	0.02	0.02	
8	Rubber tyres/asphalt	0.03	0.03	
9	Rubber tyres/gravel	0.05	0.05	

B 600 Skew load

601 Skew load is the extra loading at object support points due to inaccuracies in the level of the skidways, rolling surfaces, supports, etc.

Guidance note:

Skew loads could normally be disregarded for loadout operations where the object has a 3 point support system. This could be obtained by including a reliable load equalising system.

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

602 For cases without 3 point support systems skew load effects should be determined by considering the stiffness of the object, the supporting structure, the tolerances of skidways, rolling surfaces and supports, movement of transport vessel and link beams and load on the transport vessel.

Guidance note:

In lieu of a more refined analysis, the skew load may be determined considering the object supported on 3 points only. It may be required to assume various possible 3 point support situations.

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

B 700 Other loads

701 Any other significant loads, not covered above should be considered in the design of the object and in the planning of the operation. Such loads may include

— hydrostatic loads on transport vessel(s),
— impact loads,
— wind loads,
— local support loads on grounded barge hulls,
— mooring loads, and
— guiding loads.

C. Design Calculations

C 100 General

101 Structures and structural elements shall be verified according to principles and requirements in DNV-OS-H102. See Section 2A 200.

102 All loads described in Sub-section B shall be considered.

103 For design of the mooring system maximum loads from pushing or pulling units shall be considered.

C 200 Load cases

201 Relevant load cases shall be selected in order to identify design conditions for the object, skidding equipment or trailers, support structures and transport vessel.

Guidance note:

A loadout operation does not represent one well defined load case, but a sequence of different load cases. In principle, the entire loadout sequence should be considered step-by-step and the most critical load case for each specific element

should be identified. However, the force distribution during a loadout may normally be represented by static load cases distributing the object weight and any environmental and equipment loads to relevant elements in the analyses.

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

202 The design load cases for link beams, link beam attachments and the quay should consider mooring forces and skidding forces when relevant, foreseeing a situation where the object is jammed for some reason.

C 300 Quays

301 Allowable horizontal and vertical load capacities of loadout quays should be documented according to a recognized code or standard.

302 Calculations showing that the actual loads during loadout are equal or less than the allowable loads should be presented.

C 400 Soil

401 Strength and settlement calculations/ evaluations for the ground in the loadout area should be presented.

Guidance note:

The risk of differential ground settlements which may influence the loads during loadout, should be minimised by means as

— pre-loading of ground in loadout tracks and
— load spreading by e.g. concrete slabs or steel plates.

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

402 Soil material should normally be tested prior to construction or loadout of the object. Alternatively relevant site investigation reports should be available.

403 Geotechnical calculations and testing should be carried out according to a recognized standard, e.g. EN 1997 Eurocode 7.

404 For trailer transport the soil strength requirement apply for the whole planned path/track plus at least 2 meters at each side.

405 For loadouts involving grounded barge, the seabed should be evaluated with respect to topography, bearing capacity, settlement, etc.

D. Systems and Equipment

D 100 General

101 Systems and equipment to be used during loadout should comply with the requirements given in DNV-OS-H101, Section 6 A.

D 200 Push/pull systems

201 The push/pull systems shall be able to break loose and push/pull the object to the final position on the transport vessel.

Guidance note:

Adequate break loose capacity may be obtained by combining e.g. jacks with the continuous push/pull system

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

202 If relevant the push/pull system should be able to provide adequate braking capacity at any time.

Guidance note:

The relevance of braking capacity shall be evaluated assessing conservatively the possible (combined) effects of:

— Track slope, including maximum possible (accidental) inclinations of the loadout vessel.
— Extreme low friction, e.g. by using (steel) wheels/rollers or surfaces with (very) low friction.
— Elasticity in pull system, i.e. high elasticity (e.g. long winch wires) combined with temporary jamming could result in a “catapult effect”.

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

203 The push/pull systems for transfer of the object shall have a nominal capacity equal or greater than the minimum design capacity defined by the respective loadout class, see Table 3-3.

204 The push/pull systems should act in a synchronised manner in the transfer direction. A minimum required loadout velocity shall be identified considering;

— maximum allowable loadout duration,
— dynamic friction coefficient,

— length of the loadout track, and
— conservatively estimated duration of repair work (if such work is accepted as back up), or documented installation time for back up equipment.

205 Back-up push/pull system capacity should be able to compensate for the following conditions:

a) Breakdown of one arbitrary self-contained push/pull unit.
b) Unexpected increase in the skidding loads above the expected nominal value.

Guidance note:

The back-up capacity for accidental conditions represented by 205 a) may be separate push/pull units with nominal capacity to complete the operation in the case of a mechanical breakdown of the main system. The back-up capacity may also be spare parts of the main units, if an acceptable repair/replacement time can be proven.

The back-up capacity for conditions represented by 205 b) may be spare capacity in the main units or back-up push/pull units.

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

206 Requirements to push/pull back up systems for the respective loadout class are given in Table 3-3.

207 Any required modifications during the operation, e.g. removal of pull bars of the push/pull system lay-out should be proven feasible. Normally, lay-out modifications should be avoided with the object supported both at the quay and transport vessel.

Table 3-3 Push/pull requirements

Loadout Class	*Intact System Capacity*	*Back-up requirement after breakdown of any one component*	*Retrieval Possibility Required?*
1	160%	130% capacity, or repair documented to be feasible within 30 minutes	Yes
2	140%	120% capacity, or repair documented to be feasible within 2 hours	Recommended
3	120%	No specific, but repair feasibility shall be documented	No
4	120%	100% capacity, or repair documented to be feasible within 6 hours	Recommended
5	100%	As “Class 3”	No

Note
See B.501 for definition of 100% push/pull capacity.

208 A retrieval system and procedure for a possible retrieval shall be available for Class 1 loadouts. Such system and procedure are also recommended for Class 2 and 4 loadouts.

Guidance note:

If a retrieval system is not available this should be justified by risk assessment. An acceptable option may be to substantiate that a retrieval system could be made operative to retrieve the object within the T_R.

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

D 300 Trailers

301 Trailers (multi wheel bogies) should be used in accordance with the manufacturer's specifications.

302 The hydraulic suspension layout (linking) should be thoroughly considered. Normally a layout giving a three point support condition for the object is recommended.

303 The trailer configuration should have adequate manoeuvring capabilities for the intended loadout (including site move) route.

304 The trailer axle load calculations shall consider

— weight of object,
— weight of object supports on the trailers,
— weight of the trailers themselves,
— extreme positions of CoG,
— hydraulic suspension lay-out,
— maximum overturning effect caused by relevant “external” horizontal loads, see 307
— possible operating errors, see e.g. 308, and
— contingency situations, see 312.

305 The following shall be documented for the trailer axle loads calculated according to 304 above:

a) Axle loads to be not larger than the allowable axle load specified by the manufacturer.
b) Trailer moment and shear force within the manufacturer’s specified limits or the global (spine) strength to be documented by calculations.

c) In order to ensure adequate global stability the minimum calculated load on any trailer suspension system should not be less than 40% of the calculated nominal load on the same system.

Guidance note:

The nominal load on a trailer suspension system is the loading considering neither horizontal loads nor any CoG tolerance, from the transported unit on the system.

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

306 The support lay-out on each trailer shall ensure stability in both directions of the trailer.

Guidance note:

A trailer with a fully linked hydraulic suspension needs to be regarded more as a distributed load than as a support. The supports on such trailers should be checked for the vertical loading from the trailers combined with maximum "external" and "internal" horizontal loads acting on the trailers, see 307 and 308.

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

307 The trailers should be properly supported to withstand horizontal loads. Such loads are caused by:

a) External effects, i.e. reaction loads from wind, inertia (e.g. acceleration during start and stop) and ground slope (including vessel heel/trim).

b) Internal effects such as differential traction and steering inaccuracies.

308 Trailer inclinations due to improper co-ordination in operation of the hydraulic suspension system shall be considered.

309 The traction system, either the trailers are self-propelled or pushed/pulled by trucks/winches, should fulfil the requirements in D 200. Ground surface conditions should be duly considered.

310 It should be documented that the trailer hydraulic suspension will work well within the stroke limits. Support heights, ground slopes/conditions and defined vessel levels/motions (see E 400) should be considered.

Guidance note:

Normally the planned operational stroke should be limited to 70% of the total theoretically available stroke.

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

311 Contingency/repair procedures should at least be presented for;

— hydraulic system failure,
— hose rupture/leakage,
— tyre puncture,
— steering problems and
— traction failure, see D 200.

312 The trailer load calculations shall consider that any one axle does not take load due to e.g. tyre puncture.

Guidance note:

If repair is possible 10% overload could normally be accepted. For Class 1 load out the loading shall be within the stated maximum trailer loading.

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

D 400 Skidding equipment

401 Skid shoes, steel wheel bogies and steel rollers are in this subsection defined as skidding equipment. Any part of such equipment used for the horizontal movement of the object is defined as part of the push/pull system, see D 200.

402 Adequate strength and stability of skidding equipment should be documented. All possible combinations of vertical load, horizontal load and support reaction distribution should be verified.

Guidance note:

Skidding equipment may be connected in order to reduce internal horizontal loads transferred through the object. The effect of possible rotation of skidding equipment should be considered.

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

403 Skid way levelness tolerances, surface condition and side guides should be adequate for the applied skidding equipment.

404 For hydraulic suspension systems, see 302 and 310.

D 500 Ballasting systems

501 The requirements to the ballasting systems are given in Section 2 B. See also E401.

Guidance note:
The loadout classes defined in Table 3-1 corresponds to the operation classes referred to in Section 2 B.

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

D 600 Power supply

601 Adequate power supply and sources for the ballast pumps and for the push/pull units should be ensured during the loadout.

Guidance note:
Need for additional power supply to e.g. lighting and welding should be considered.

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

602 The need for emergency power supply due to the following situations shall be considered:

a) Breakdown of one arbitrary power unit.
b) Breakdown of the common energy supply.
c) Unexpected increase in the consumption of energy above the expected value.

Guidance note:
The back-up capacity for accidental conditions represented by 602 a) and b) may be spare units in stand-by position. The back-up capacity for conditions represented by 602 c) may be spare capacity in the main unit or a back-up unit installed to assist the main unit.

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

603 Sufficient main and back-up power supply capacity should be documented by calculations.

Guidance note:
Necessary power supply for ballasting should be based in the required ballasting capacity given in Table 2-2 for the relevant loadout class. For evaluations of back-up requirements, an independent power supply source should be regarded as a "pump system", see note c) in Table 2-2.

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

D 700 Testing

701 See general requirements in DNV-OS-H101, Section 4 F with respect to testing/commissioning, test procedures and test reporting.

702 Commissioning of the ballast pumps should at least include

— capacity control and
— final functional testing not more than two hours before start of the operation.

Guidance note:
Pump capacity control should be carried out with equal or greater head and similar hose lengths as planned used during the operation. If tank ullages are used as capacity measuring means, the pumped volumes should be sufficient to obtain minimum 300 mm difference in ullages before and after pumping.

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

703 For loadout operations of Class 1 a complete test run of the ballast system following the procedure for the loadout should be carried out.

704 The push/pull units including the spare units should be tested in both push and pull mode prior to the loadout operation in order to verify the estimated friction forces and functioning/capacities of the equipment.

705 If the considered back-up necessitate replacement of equipment (e.g. pumps and push/pull units) this should be included in the test program.

D 800 Mooring and fendering

801 General design requirements to mooring systems are given in DNV-OS-H101, Section 6 B. Additional requirements applicable for loadouts are given below.

802 For additional load cases to be considered see C103 C202 (and C103 C202).

803 Facilities for re-tensioning of mooring lines should be present and in stand-by during the loadout.

Guidance note:
Such facilities may be winches, jacks for tensioning, etc.

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

804 The stiffness of the mooring system shall be sufficient to avoid any horizontal movements of the loadout vessel that could be critical for an object during loadout, i.e. when supported both on the quay and vessel.

805 Adequate strength, stiffness and layout of fenders should be documented.

Guidance note:

Fender design solutions should at least consider;

— requirement to a stiff mooring system during loadout (see 804)
— effect of extreme tide variations
— possible impact loads
— the possibility that the vessel could "hang" on the fenders, see also F202.

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

806 Friction between the vessel and support pad considered as a part of the mooring system in grounded loadouts (see G100) shall be properly documented.

Guidance note:

The calculations of friction effect should at least consider:

— the documented lower bound design friction. See DNV-OS-H102
— minimum vertical load on the pad considering all relevant ballast, tide level and deck loading combinations
— any limitations due to interaction between mooring system and the friction effect.

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

E. Vessel(s)

E 100 General

101 General requirements to vessel(s) are given in DNV-OS-H101, Section 6 D. These requirements are applicable to any vessel involved in the loadout.

102 See Section 2 C300 for requirements to vessel documentation.

103 For tugs involved in the loadout the requirements in DNV-OS-H202 apply as relevant for the actual tug work tasks.

104 The loadout vessel, see Section 1 C100, will in most cases be a barge and the relevant requirements in DNV-OS-H202 hence apply.

E 200 Structural strength

201 The loadout vessel global strength shall be documented for all possible ballast conditions, see also DNV-OS-H202.

202 The strength should be documented for all parts of the vessel exposed to local loads. Such parts are typically;

a) link beam/plate support area
b) skid way (launch-way and rocker arm), including support area
c) deck plate for wheel loading
d) push/pull system connection points
e) hull locally for horizontal loads from the quay
f) bottom structure, if grounded loadout
g) bollards/mooring brackets.

E 300 Stability afloat

301 Sufficient stability afloat should be ensured during loadout. The minimum requirements to intact stability are given in DNV-OS-H101, Section 5 D200.

Guidance note:

Normally there is no requirement to document damage stability during loadout. However, it may be applicable to investigate the effect on the stability of incorrect operation of the ballast system.

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

302 For loadout operations the minimum "effective freeboard" should for barges be;

$$f_{min} = 0.5\ m + H_{max}/2$$

where

f_{min}: Minimum effective freeboard, see the guidance note below.

H_{max}: Maximum anticipated wave height at the site during loadout.

Guidance note 1:

The "effective freeboard" is defined as the minimum vertical distance from the water surface to any opening, e.g. an open manhole. A maximum possible tide level and any possible barge heel/trim should be considered. Coamings at openings could be installed to increase the "effective freeboard".

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

Guidance note 2:

In order to use a barge with less freeboard than defined by the load line certificate approval from class is required.

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

E 400 Loadout vessel draught and motions

401 Nominal values- and allowable tolerances for the loadout vessel(s) level, trim and heel shall be clearly defined for all stages of the loadout.

402 It should be documented, if required by calculations, that the values defined according to 401 are adequate to prohibit unexpected (load) effects.

403 Wave/swell induced motions of the loadout vessel is normally not acceptable during the operation. See B 402.

E 500 Maintenance

501 A vessel (barge) handling procedure should normally be presented. The procedure should as a minimum describe:

— berthing and if applicable relocation
— vessel surveys e.g. on-hire and off-hire surveys, condition surveys
— installation and inspection of moorings
— general watch keeping.

502 A barge engineer familiar with operation and maintenance of the barge equipment should be present if any barge equipment is used (or considered as back-up) during critical phases of the loadout.

503 Precautions in order to avoid freezing in tanks and ballast systems should, if relevant, be taken.

Guidance note:

Such arrangements may be heating devices (in pump rooms), additive anti-freeze solution, or any other devices or actions serving the above purpose.

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

F. Operational Aspects

F 100 General

101 Operational requirements are generally described in Section 2 D.

F 200 Loadout site

201 Sufficient under-keel clearance should be documented for vessel(s) during and after the loadout operation. Normally the clearance should not be less than 0.5 meters.

Guidance note:

The seabed should be inspected by divers or by an adequate survey method if the vessel under-keel clearance is considered as critical.

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

202 Due attention should be paid to the possibility for the vessel to "hang" on the fenders or the quay structures.

203 A level control of the site area should be performed for loadouts with trailers to ensure that the level tolerances of the trailers will not be exceeded.

204 Planned trailer tracks should provide an adequate surface condition and the tracks should be marked on the ground and vessel.

F 300 Supports and skidways

301 Object support (and, if applicable, skid way- and temporary support-) levels and horizontal dimensions on the loadout vessel should be thoroughly checked to be correct, i.e. within acceptable tolerances.

302 Nominal set down position and set down tolerances should be marked on the supports on the loadout vessel.

303 Suitable shims should be available on the loadout vessel for filling of gaps if required during set down.

304 It should be ensured that skid way surface condition is as assumed in the friction coefficient estimate.

F 400 Grillage and seafastening

401 The main requirements for the grillage and seafastening structures of the transported object are presented in DNV-OS-H202.

402 A set down procedure for the object should be used in order to ensure that the grillage and seafastening design assumptions are fulfilled.

403 The seafastening should commence immediately after final position of the object on the loadout (transport) vessel is confirmed. However, see Section 2 B603.

404 The object should be secured to the barge (loadout vessel) to withstand possible impact loads and/or any heel and trim prior to moving the barge to another location at the same site for further seafastening. Normally a horizontal characteristic acceleration of minimum 0.1g should be considered in any direction.

Guidance note:

This condition should be checked with load- and material factors for relevant failure mode(s) in ULS. Friction may be considered as described in DNV-OS-H102, Sec.4 A600 in the calculations of necessary seafastening capacity.

It should be justified that impacts (e.g. between barge and quay) will not cause displacements of the object that may jeopardize the integrity of the object vertical supports.

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

F 500 Monitoring

501 The following loadout parameters should as applicable be monitored and recorded, see Section 2 D400, prior to and/or during the operation:

a) tide
b) push/pull force
c) straightness and levelness of skidding tracks
d) inclination of link beam
e) level and vertical deflections of the object
f) horizontal position of the object
g) vessel draught and/or level
h) vessel heel and trim
i) water level in vessel tanks
j) hydraulic pressure and stroke on any support/equalising jack, e.g. trailer hydraulic suspension.

Guidance note:

Normally a remote reading sounding system should be used for tank water level control. A back-up system but not necessarily remotely controlled (e.g. hand ullageing) should be provided. If access to any tank is obstructed, e.g. by seafastening supports, alternative access should be arranged.

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

G. Special Cases

G 100 Grounded loadouts

101 If the barge (loadout vessel) is supported at the sea bottom during the load transfer phase it is defined as a grounded loadout.

102 Seabed support pad(s) should be prepared considering:

a) any protruding elements (e.g. anodes and bilge keels) on the vessel bottom
b) soil bearing capacities, see also C403
c) stability and global deflections of the vessel
d) vessel bottom local strength
e) required sliding resistance (friction).

103 Acceptable safety margins should be documented for all relevant load effects, see sub-section C, for the items b) to e) in 102 above.

Guidance note:

Maximum vessel bottom loading at the extreme low tide throughout the period should be considered.

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

104 In addition to condition and level survey(s) of the support pad(s) a diver or side-scan survey should be carried out shortly before the vessel is positioned.

105 The vessel should be positioned and ballasted onto the pad several tidal periods before the loadout to allow for consolidation and settlement. Pad loading to reflect the loadout loading condition(s) and vessel levels to be monitored during this period.

Guidance note:

Pre-loading in excess of the maximum loading during loadout may be used to reduce the required period for pad consolidation and settlement.

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

106 A detailed procedure covering both positioning on the pads and the float-off operation following the loadout shall be made.

G 200 Transverse barge loadouts

201 Generally transverse loadouts are more sensitive to variations in object weight and CoG as well as to inaccuracies (between theoretical and actual) moved distance, ballasting and tide levels. This shall be duly considered both in the ballast calculations and in the monitoring/control procedures. See also B204.

202 A small GM may be more critical than for an end-on loadout as the heel may change significantly due to minor inaccuracies. Hence, it is recommended that the GM is as high as possible and that the moment to change the vessel heel by 0.1 m is computed (and shown in the operation manual) for all stages of the loadout.

203 As the vessel (accidental) heel can be significant, braking possibility for the (skidded) object should be provided. See D202.

G 300 Load-in

301 Requirements to loadout operations are generally applicable for load-in operations as well.

302 As loadout is the usual operation special attention should be paid to items as optimal tide phase for the operation and ballast requirements.

G 400 Vessel to vessel load transfer

401 A vessel to vessel load transfer operation is defined as the activities necessary to transfer an object between vessel(s) doing mainly a horizontal movement of the object.

402 Requirements to loadout operations are generally applicable for vessel to vessel load transfer operations as well.

403 Vessel to vessel load transfer operations could be complex involving more than two vessel(s), and different support conditions on one or more of the vessel(s). Due attention should be paid to this fact during planning, design and execution of the operation.

Guidance note:

For these operations measurements of the vessel(s) draught, trim and heel may not be sufficient to control the load distribution.

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

404 Tide effects can be neglected for operations involving only floating vessel(s) if sufficient bottom clearance is ensured. Hence, the operation could be defined as loadout (operation) Class 4 or 5.

SECTION 4
FLOAT-OUT

A. General

A 100 Application

101 This section applies to objects such as gravity base structures, jacket substructures, loading towers, etc. fabricated in a dry dock, brought afloat and floated out from the fabrication site.

A 200 Planning and design basis

201 General requirements are given in Section 2 A100.

202 Any local environmental effects should be identified and considered.

203 Sensitivity studies, see DNV-OS-H102, Section 4 A200, should include evaluation of

— time limitations due to the tide
— extreme tide variations due to atmospheric and local environmental effects
— limiting environmental conditions
— accidental conditions
— structural limitations.

A 300 Documentation

301 See Section 2 C for requirements to documentation.

B. Loads

B 100 General

101 The requirements to loads and design in Section 2A 200 apply.

B 200 Weight

201 The weight of the object should be calculated on the basis of accurate specific weights and volumes and/or weighed or estimated weights of parts of the object, equipment, etc.

202 The requirements of Section 3 B200 apply.

B 300 Buoyancy

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

302 The final buoyancy estimate should take place when the final geometry of the object is established.

B 400 Other loads

401 All loads which may occur due to effects such as hydrostatic pressure, impacts, mooring, guiding, pulling by tugs and winches, etc. should be considered in the design of the object and in the planning of the operation.

402 The value of other loads should be determined considering operational and equipment limitations. For determination of accidental loads possible failure modes should be sought for.

C. Load Effects and Analyses

C 100 General

101 All relevant load effects, see DNV-OS-H102, Section 4, shall be considered.

C 200 Load cases

201 A float-out operation represents different load cases from the condition when the self-weight is resting on the fabrication supports to the self-floating condition. In principle, the entire float-out sequence should be considered step-by-step and the most critical load case for each specific member should be identified.

202 The float-out operation represents a load case for the towing/positioning winches, wires, brackets, quick release hooks, etc. These structures should be capable of withstanding relevant environmental loads in addition to the positioning/towing loads.

203 Additional load cases due to environmental loads (mooring forces, etc.) should be considered for the relevant structures (mooring equipment, etc.).

C 300 Structures

301 Structures should be designed as indicated in DNV-OS-H102.

Guidance note:

The global structural analysis required for verification of the integrity of the structure for the float-out operation may be omitted provided that analyses show that other operations or conditions represent a more severe condition for the design.

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

C 400 Stability afloat

401 The stability requirements in DNV-OS-H101, Section 5 C apply.

D. Systems and Equipment

D 100 General

101 Systems and equipment to be used during float-out should comply with the requirements given in DNV-OS-H101, Section 6 A.

D 200 Installation systems

201 The installation systems or parts thereof (piping for flooding, grouting, skirt water evaluation, etc.) should be inspected for blockage prior to dry-dock flooding.

Guidance note:

The dry-dock area should be cleaned to avoid blockage of piping outlets/inlets due to debris, etc. Filter boxes, plugs, etc., should be attached to piping outlets/inlets, if necessary, to avoid blockage.

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

D 300 Air cushion systems

301 To achieve sufficient bottom clearance during the operations, air cushions may be applied under the bottom slabs of the object. An adequate water seal should be used.

Guidance note:

The water seal should be specified considering the under base compartmentalisation, environmental conditions, motions during operation, horizontal speed and the consequences of loss of air. Normally, a water seal of minimum 0.5 meters should be used.

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

302 The system should have adequate redundancy in all parts such that breakdown of one arbitrary delivery line, compressor or generator does not adversely affect the operation.

303 The air leakage from the air cushions prior to lift-off shall be less than 5% of the compressor capacity. After lift-off leakage shall be monitored to assess the feasibility of continuing the operation.

304 A proper venting system should be designed to ensure that all trapped air under the base can be let out when planned.

D 400 Mooring, Positioning and Towing system

401 The mooring, positioning and towing systems (wires, quick release hooks, winches, etc.) should be capable of controlling the object during the operations.

402 Design requirements to mooring systems are given in DNV-OS-H101, Section 6 C.

403 The positioning and towing systems should be designed to manoeuvre the structure at a safe distance, see E201, from the dry-dock sides and dock gates.

E. Operational Aspects

E 100 General

101 Operational requirements are generally described in Section 2 D.

102 The dry-dock including the float out channel outside the dry-dock should be surveyed prior to float-out to verify that the required minimum under-keel clearance will be maintained throughout the float-out operation.

E 200 Clearances

201 Sufficient side and vertical (bottom) clearances should be ensured considering;

— the operational arrangement
— design environmental (waves/swell, current and wind) conditions
— minimum tide level
— equipment and vessel(s) to be used,
— dock water inlet requirements
— consequences of failure or malfunctioning of any one of the pulling sources
— guiding and fendering arrangements
— float-out velocity.

Guidance note 1:

The minimum vertical bottom clearance should not be less than 0.5 meters considering the maximum draught, motions and applicable trim and heel. Adequate under-keel clearance should be documented until a reasonable distance from the dock exit.

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

Guidance note 1:

Normally a minimum width of 1.2 times the object breadth is recommended for the channel from the dock entrance/ gate to open water. If the object is floated out under winch control along a fender at one of the channel sides, a minimum channel width of 1.05 times the object breadth is recommended. Channel width less than 1.05 times object breadth should be specially considered. If the channel width is greater than 4 times the object breadth, it may be regarded as open water, see DNV-OS-H202

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

E 300 Monitoring

301 Monitoring and recording, see Section 2 D400, of

— draught, trim, and under-keel clearance
— position and orientation of the object
— environmental conditions including tide
— air pressure in air pressurised compartments
— air leakage
— water plug.

should be carried out prior to and/or during the float out operation.

SECTION 5
LIFT-OFF

A. General

A 100 Application

101 This section applies to objects such as offshore modules and deck structures lifted off ground supports. Lift-off may be carried out by one or several vessel(s) (barges).

102 Lift-off includes all activities from lift-off vessel positioning until the object is lifted to an acceptable height for tow out (or safe mooring) above the construction supports.

Guidance note:

The weight of the object is normally transferred from the supports to the vessel(s) by de-ballasting of the vessel(s) at rising tide.

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

103 The lift-off operations described in this section are considered carried out in sheltered waters. For offshore lift-off operations (e.g. during platform removal) special precautions need to be applied. See Section 7 B200 to Section 7 B400 for guidance.

104 The requirements related to tow out of the object are given in DNV-OS-H202.

A 200 Lift-off class

201 A lift-off class should as for loadout, see Section 3 A200, be defined according to Table 5-1.

Table 5-1 Lift-off class definition

Tide range	*Tide restrictions*	*Weather restrictions*	*Lift-off Class*
Significant	Yes	No/Yes	1
Significant	No	Yes	2
Significant	No	No	3
Zero	No	Yes	4
Zero	No	No	5

A 300 Planning and design basis

301 General requirements are given in Section 2 A100.

302 Tide variation, which is normally the most critical parameter for lift-off, should be specially evaluated.

303 The operation reference period, T_R, defined in DNV-OS-H101, Section 4 B should be established at an early stage. The start and stop points for the lift-off should be clearly defined.

304 Any local environmental effects, e.g. the possibility of swell/waves at the lift-off site, should be identified and considered.

305 Other items of importance for the lift-off planning are normally

— construction support lay-out, including position of object
— requirements to support heights and lay-out of vessel supports and vessel(s)
— vessel(s) dimensions and strength
— water depths
— quay and ground strength/condition
— accidental conditions
— structural limitations for object, vessel supports, and vessel(s).

A 400 Documentation

See Section 2 C for requirements to documentation.

B. Loads

B 100 General

101 See Section 2 A200 for general requirements to loads and design.

B 200 Weight and CoG

201 Weight and CoG shall be determined as described in DNV-OS-H102, Section 3 C.

202 The requirements in Section 3 B200 and Section 3 B300 Section 3 B300 should be considered.

B 300 Environmental loads

301 All relevant wave lengths including swell type wave lengths shall be considered.

302 First order wave loads need to be considered for stiff securing/mooring systems, such as

— mooring arrangements including short lines without catenary, and
— objects partly supported by vessel(s) and partly by land/seabed supports.

B 400 Skew loads

401 Skew loads are here defined as the variation in support reactions due to fabrication- and operation inaccuracies. All possible skew loads should be evaluated and included in the relevant strength calculations if the effect cannot be proven insignificant.

Guidance note:

Operational precautions such as shimming, monitoring, etc., may be used prior to and during the operation in order to reduce/eliminate potential skew loads.

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

402 Items which may cause skew load effects are:

— fabrication tolerances for the object and for the vessel supports
— fabrication tolerances for the vessel(s)
— vertical offset of the object for each support condition
— vessel heel and trim variations
— movement of vessel centre of buoyancy, gravity and flotation relative to draught and ballast configuration
— inaccurate positioning of vessel(s) relative to the object supports
— deformation of the object and the vessel(s) including the possible introduction of horizontal loads.

B 500 Other loads

501 The corresponding requirements of Section 4 B400 apply.

C. Load Effects and Analyses

C 100 Load effects and load cases

101 The lift-off operation, from initial contact through completed lift-off, represents theoretically an infinite number of load cases for both the object and the vessel(s). Hence, the entire lift-off operation should be considered step-by-step and the most critical load case for each specific member of the object should be identified.

102 Local load effects due to ballast content in the vessel(s) and due to global deformations of the object and the vessel(s) should be considered.

103 Accidental load conditions should be identified, see DNV-OS-H102, Section 3 F. Identified accidental loads that cannot be neglected due to low probability, see DNV-OS-H101, Section 2 C, should be included in the design calculations.

C 200 Calculations and analysis

201 The load cases required to adequately combine all identified load effects should be analysed as static load cases by distributing the self-weight, vessel support forces, and other loads to the actual members of the object.

202 Local loads on the object and on the vessel(s) during positioning and mooring at the construction site after lift-off should be included as found relevant in the calculations/analysis.

203 Forces in anchoring, mooring and fendering equipment/structures due to functional and environmental loads should be considered.

204 The force distribution in the object and in the vessel(s), and their global deflections, should preferably be determined by a 3-dimensional analysis.

D. Structures

D 100 General

101 Structures shall fulfil the relevant requirements in DNV-OS-H102.

D 200 Object

201 Special attention should be paid to the assessment of local support loads from the vessel supports and other external loads.

202 Vertical deflection tolerances should be specified from the structural analysis of the object such that unacceptable vertical deflections may be avoided. The selected deflection tolerances shall consider the practical limitations of the shimming procedure.

D 300 Construction supports

301 The construction supports should have sufficient strength to withstand the object self-weight and relevant skew loads, relevant impact loads from vessel(s), mooring forces, forces due to environmental loads, etc., occurring during the lift-off operation.

D 400 Vessel supports

401 The vessel supports should have sufficient strength to withstand all vertical and horizontal forces during lift-off.

Guidance note:

The horizontal forces may be reduced by decreasing the horizontal restraint by means of e.g. low friction surfaces.

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

402 The vertical load distribution to all supports should be controllable. I.e. it should be ensured that the support reactions throughout the load transfer are within the allowable reaction loads.

Guidance note:

The reactions could be controlled by one or a combination of the following means:

— support load monitoring
— hydraulic load distribution system
— shimming of the vessel supports in accordance with an appropriate procedure. (Possible as-built deviations and calculations inaccuracies, etc. should be accounted for)
— a flexible support system to be used between the top of the vessel supports and the object. (The flexible support system may be obtained by using crushing tubes, lead plates, wood, wedge systems or similar.)

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

E. Systems and Equipment

E 100 General

101 The systems used for lift-off should be designed, fabricated, installed and tested according to DNV-OS-H101, Section 6 A.

E 200 Ballasting systems

The requirements to the ballasting systems are given in Section 2 B.

Guidance note:

The lift-off class defined in Table 5-1 corresponds to the operation class referred to in Section 2 B.

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

E 300 Positioning systems

301 General design requirements for mooring and positioning systems are given in DNV-OS-H101, Sections 6 B and 6 C. Other additional requirements applicable for lift-off are given below.

302 The load cases described in C202 and C203 should be considered.

303 Horizontal load bearing capacity between the object and the construction supports considered as part of the mooring shall be thoroughly documented.

304 Facilities to re-tension mooring lines should be available and in stand by position during the lift-off. Such facilities may be winches, jacks for tensioning, etc.

305 Fendering structures should be arranged on the vessel sides or the construction pillars to prevent damages to the vessel(s) during the lift-off operation.

306 The vessel(s) should be equipped with guides to ensure accurate positioning underneath the object prior to commencing the lift-off operation.

307 The positioning and mooring system should provide for correct alignment and securing of the vessel(s) during all phases of the operation.

308 See Table 7-2 for contingency requirements to the system during- and after load transfer.

F. Lift-off vessel(s)

F 100 General

101 Requirements to vessel(s) are given in DNV-OS-H101, Section 6 D and Section 2 C300.

102 See Section 3 E500 for requirements to vessel maintenance.

F 200 Structural strength

201 General requirements to vessel structural strength verification are given in DNV-OS-H202.

202 The vessel deflections should be maintained within an acceptable range during lift-off by selecting adequate ballast configurations for each vessel.

203 Tolerances for the vessel deflections should be established considering the maximum allowable skew loads at the vessel supports.

F 300 Stability afloat

301 Special attention should be paid to accurate interpretation and application of hydrostatic data for the vessel(s). For complicated operations inclining tests may be relevant to verify the hydrostatic stability parameters.

302 Sufficient stability afloat should be ensured for single vessels during positioning. The following requirements apply for barges;

a) $GM \geq {}_{1.0m}$

b) DNV-OS-H101, Section 5 B

c) $f_{min} = 0.3m + H_{max}/2$, see also Section 3 E302.

303 The requirements to stability after lift-off are given in DNV-OS-H101, Section 5 B.

304 For lift-off operations carried out with open barge manholes the minimum "effective freeboard" (f_{min}) during load transfer, including any defined "stop point" before lift-off, should be;

$f_{min} = 0.5m + H_{max}/2$, see also Section 3 E302.

G. Operational Aspects

G 100 General

101 Operational requirements are generally described in Section 2 D.

G 200 Lift-off site

201 The lift-off site including the seabed should be surveyed prior to installation of the vessel(s). The survey should verify that the vessel(s) vertical and lateral clearances are acceptable for the planned operation, see G400.

202 Obstacles that may damage the vessel(s) or impede the operation should be removed.

G 300 Preparations

301 The requirements of Section 2 D100 apply.

302 If grounded vessel(s) will be used this should be considered in the site preparations, see Section 3 G100.

G 400 Clearances

401 Sufficient vertical clearance, considering any possible heel, trim and/or motion, shall be maintained between the underside of the object and the top of the vessel supports during positioning of vessel(s) and prior to the weight transfer operation.

Guidance note:

This clearance should relative to a reference tide level, not be less than neither 25% of the tide variation nor 0.25 meters. The reference tide level should be defined taking adequately into account the operation procedure/schedule including contingencies.

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

402 During possible mooring at the construction supports after weight transfer from these to the vessel(s) sufficient clearance shall be ensured between the underside of the object and the top of the construction supports.

Guidance note:

The minimum vertical clearance at low tide should not be less than neither 25% of the tide variation nor 0.25 meters.

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

403 Sufficient horizontal clearance between vessel(s) and construction supports should be ensured throughout the operation.

404 Sufficient under-keel clearance should be documented for vessels during positioning. Normally the clearance should not be less than 0.5 meters.

405 During the weight transfer operation and after the lift-off operation a minimum under-keel clearance of 0.5 meters shall be maintained.

G 500 Monitoring and monitoring systems

501 The following lift-off parameters should as applicable be monitored and recorded, see D400, prior to and during the operation:

a) tide
b) swell
c) support reactions
d) object deflections
e) vessel deflections and draught
f) water level in vessel tanks
g) air pressure in air pressurised vessel compartments
h) clearance between the vessel supports and the object
i) seabed clearances
j) clearance between construction supports and the related object.

Guidance note 1:

Normally a remote reading sounding system should be used for tank water level control. A back-up system but not necessarily remotely controlled (e.g. hand ullageing) should be provided. If access to any tank is obstructed, e.g. by seafastening supports, alternative access should be arranged.

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

Guidance note 2:

Support reaction measurements and comparison of the results with the actual ballast water and tide situation should be performed continuously during the lift-off. The actual deviation in total load and moments should be noted for each measurement and compared with agreed tolerances.

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

SECTION 6
MATING

A. General

A 100 Application

101 This section applies to mating operations, see Section 1 C100.

102 The typical mating operations covered in this section are joining heavy deck structures (objects) supported by transport vessel(s) together with floating substructures as

— gravity base structures or
— other floating substructures, i.e. hulls.

103 Mating includes ballasting of the substructure, positioning, weight transfer from vessel(s) to the substructure, and de-ballasting of the substructure to final draught, see also Section 8.

104 The mating operations described in this section are considered carried out in sheltered waters. For offshore mating operations special precautions need to be applied. See Section 7 B200 to Section 7 B500 for guidance.

A 200 Planning and design basis

201 See Section 2 A for general requirements.

202 The following parameters should be considered in relation to operational feasibility and structural limitations of the object on vessel(s) and the substructure:

— environmental conditions
— time limitations determined by the weather forecasting period
— topographical limitations
— structural limitations for object, vessel(s), vessel supports, substructure, etc.
— freeboard and hydrostatic stability.

A 300 Documentation

301 See Section 2 C for requirements to documentation.

B. Loads

B 100 General

The loads given in Section 2 A200 should be considered for the mating operation.

B 200 Skew loads

201 The requirements in Section 5 B400 shall be considered.

Guidance note:

The items listed in Section 5 B402 should be considered as relevant. In addition fabrication tolerances including supports and possible heel and trim variations of the sub-structure should be considered.

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

202 The load transfer procedure shall consider any requirements to limiting “built-in” skew load effects.

Guidance note:

Analyses should be performed as required to find the skew loading effects that could remain as permanent (“built-in”) loads after completion of the mating.

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

C. Load Effects and Analyses

C 100 Basic load cases and force distribution

101 The basic load cases for the object on vessel(s) and the substructure should be determined by evaluating the following activities:

— Ballasting of the substructure to mating draught.

— Positioning of the object on vessel(s) above the substructure.
— De-ballasting of the substructure to contact with the object.
— Object weight transfer from the vessel(s) to the substructure by combined de-ballasting of the substructure and ballasting of the vessel(s).
— Removal of the vessel(s) and de-ballasting of the substructure to the defined inshore safe condition/towing draught.

102 Each phase of the mating operation should be considered step-by-step and the most critical load case for each specific member of the structures should be identified.

103 The basic load cases for the substructure are determined by loads from;

— external/internal hydrostatic pressure,
— internal transfer of ballast water and
— object self-weight.

104 The basic load cases for the object on vessel(s) are determined by loads from;

— transfer of object self-weight from the vessel(s) to the substructure, and
— transfer of ballast water in the vessel(s).

105 The load cases given in 103 and 104 may be analysed as static load cases.

C 200 Additional load cases

201 Positioning and mooring loads acting on the substructure or the object on vessel(s) should be considered. Adequate protection against positioning loads should be ensured.

202 Motion amplitudes due to waves should be determined according to DNV-OS-H102, Section 4 B.

203 All realistic accidental load conditions should be identified, see DNV-OS-H102, Section 3 F. Identified accidental loads that cannot be neglected due to low probability, see DNV-OS-H101, Section 2 C100, should be included in the design calculations.

C 300 Object horizontal restraint

301 Adequately horizontally support between object and substructure shall be ensured from the load transfer commences.

Guidance note:

The position system, see Section 5 E300, E400, could be considered in the load transfer phase. The effects of friction may be taken into account.

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

302 The horizontal restraint (support) capability shall be designed considering all relevant loads including effect of maximum heel/trim due to defined damage cases.

Guidance note:

Damage cases that cannot be disregarded due to low probability should be considered. It could also be relevant just to define a maximum heel/trim as an accidental design case. Normally it is acceptable to consider damage cases only in the phase after de-ballasting to the planned (minimum safe condition) draught. Wind heel and possible effects of current and waves should be considered. Horizontal restraints should be verified for ULS and/or ALS according to the defined loads and load cases. See DNV-OS-H102, Table 3.1.

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

D. Structures

D 100 General

101 Structures shall be designed as indicated in DNV-OS-H102.

D 200 Vessel supports

201 The vessel supports should have sufficient strength to withstand all vertical forces and horizontal forces introduced by deflections of the object and the vessel(s) during object weight transfer.

D 300 Substructure

301 The substructure should be protected against possible accidental loads such as mooring line failure (not relevant if the mooring lines are slack during mating), flooding of buoyant compartments, dropped objects, collision loads, etc., during the mating operation.

E. Systems and Equipment

E 100 General

101 The mating systems should be designed, fabricated, installed, tested (commissioned) according to DNV-OS-H101, Section 6 A.

E 200 Vessel(s) ballast system(s)

201 The requirements given in Section 2 B apply. There is no tide influence, as the substructure is floating. Hence operation class 4 (or 5) is applicable.

E 300 Substructure ballasting systems

301 The de-ballast systems should have sufficient capacity to complete the mating operation within the planned operation period (T_{POP}).

Guidance note:
See Table 2-2 for guidance.

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

302 Failure of one valve used for ballasting/de-ballasting shall not cause uncontrolled filling/draining of tanks on self-floating structures not complying with the one compartment damage stability requirement, see DNV-OS-H101, Section 5 C300.

303 Adequate back-up should be available for all ballast pumps, compressors, and generators.

Guidance note:
See Table 2-3 for guidance.

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

304 The ballasting systems should be capable of levelling the structure by eccentric ballasting/ de-ballasting to compensate for any shift in the centre of gravity during the mating operation.

305 Pipe systems and valves should be designed to prevent accidental cross flooding and uncontrolled ingress of water.

306 Sealings around cables, pipes etc. penetrating a water tight bulkhead should be designed for the maximum possible differential pressure duly considering all phases of the operation.

307 Ballast compartments, which are intended to remain dry, should have adequate drainage capability to eliminate free surface effect from possible ingress of water. Water detection sensors/equipment should be evaluated.

Guidance note:
If the filling rate could (i.e. in case of accidental type ingress of water) be higher than the drainage capability this should be considered in a damage stability check.

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

308 Air venting systems from cells and ballast compartments should have adequate monitoring and control to prevent excess structural loading during ballasting and de-ballasting of compartments.

309 Umbilicals for remote power and control should be adequately protected and be backed up by additional systems to cover breakdowns or rupture.

310 Power and control systems should have adequate redundancy to cover failures to ensure object transfer within the defined period.

311 Immersion trials should be performed at selected draughts prior to the mating operation. These trials should be used to test the performance of the pumps, power/control systems and water tightness of the structure.

Guidance note:
Some items that should be considered are:

— Selected draughts should normally at least include the deepest draught during mating.
— Where to check/inspect for leakages/water ingress (pump rooms, along piping, at valves, where pipes etc. penetrate tank walls, in bottom of access shafts?) to be carefully evaluated.
— Check of tank levels, drafts, heel, trim etc. over a time interval; e.g. remain at max submergence draft for a minimum time.
— How to do with sufficiently high accuracy draught readings at columns when there are waves at mating site?
— How to ensure that computer tank monitoring system works properly and show correct water level in all tanks? E.g. check against calculations and/or check sensor readings by other means of tank level readings.
— Proper monitoring of all relevant parameters should be done, see Section 6 F501 for guidance.
— Primary positioning system.

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

312 General requirements to guiding and positioning systems are given in DNV-OS-H101, Section 6 C.

313 The substructure and the object on vessel(s) should be secured by primary positioning systems, which normally are

— a permanent mooring system for the substructure, see DNV-OS-H101, Section 6 B
— the towing fleet for the object on vessel(s), see DNV-OS-H202.

314 The primary positioning system should be capable of securing the structures in the event that the mating operation is interrupted.

315 The primary positioning system should be sufficiently accurate to ensure safe navigation and positioning of the object on vessel(s) close to the substructure.

E 400 Secondary positioning system

401 The secondary positioning system should ensure accurate and well controlled positioning of the object on vessel(s) above the substructure.

Guidance note:

It should be documented that the positioning could take place without contact with unprotected areas of the substructure, and without local impact loads exceeding the energy absorption capability of positioning bumpers/ fenders. The effect of environmental effects should be considered. Especially varying wind and current may be of significant importance. (See also F403 and F404)

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

402 The secondary positioning system (winches, wires, jacks, fenders, etc.) should have sufficient capacity to resist inertia (impact) forces, wind forces, current forces, friction forces, etc. (See 312).

403 See Table 7-2 for requirements to redundancy and back-up. Mating is normally be defined as operation class 4.

F. Operational Aspects

F 100 General

101 Operational requirements are generally described in Section 2 D.

102 The minimum freeboard during the mating operation should neither be less than 4 meters nor less than the freeboard required to maintain 5% spare buoyancy of the substructure.

Guidance note:

For large concrete gravity base structures with open shafts the minimum freeboard should normally be 6 meters. However, the minimum spare buoyancy requirement may in this case be reduced to 3%.

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

103 During mating, the relative movements of the structures due to environmental loads should be carefully considered.

104 All back-up systems should be ready for immediate activation during the critical stages of the mating operation.

105 For mating operations involving substructure draughts greater than normally acceptable the schedules for mating should be carefully planned in order to minimise the time at the maximum draught.

Guidance note:

In event of delays the substructure should be returned to an acceptable stand-by draught. For gravity base structure the minimum freeboard should not be less than 20 meters or the spare buoyancy should be minimum 10%. The substructure should have the capability of remaining at the stand-by draught for an indefinite period.

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

F 200 Mating site

201 The following criteria should be considered in the selection of the mating site:

— Environmental conditions.
— Magnitude and direction of wind, waves, and current, protection against swell, etc.
— Geographical limitations.
— Feasibility of towing the object on vessel(s) to the mating site, searoom for mooring, minimum water depth, etc.

202 The seabed at the mating site should be surveyed prior to submergence of the substructure to mating draught, if the seabed clearance is considered critical.

203 The location where mating will take place should be investigated for the possibility of variations in the density of the water. If rapid changes in density is possible, density measurements should be performed prior to and during the mating.

F 300 Preparations

301 The requirements of Section 2 D200 apply.

302 All connections between the vessel(s) and the object structure, which may hamper the lift-off, should be properly removed prior to commencement of weight transfer.

303 A seabed survey at the site must be available, covering the total excursion area. The depth contour lines shall be drawn in sufficient detail to give an adequate indication of seabed profile, considering the seabed slopes and actual clearances encountered.

F 400 Clearances

401 Sufficient under-keel clearance for the substructure should be ensured at the maximum mating draught considering minimum tide and any possible heel, trim and/or motions.

Guidance note:

The bottom clearance should normally be at least:

— 10% of the water depth limited to 10 meters for a GBS
— 2 meters for a (permanently) floating substructure.

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

402 The extension of the area giving adequate bottom clearance shall be defined. Positioning accuracy, maximum excursions caused by the environmental loads plus an adequate margin should be considered.

Guidance note:

Normally "adequate margin" should be defined as minimum half the diameter of the substructure at its lower end.

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

403 Sufficient clearances between object or vessel(s) and unprotected parts of the substructure should be ensured considering any possible heel, trim and/or motions.

Guidance note:

The following minimum values are recommended:

— 0.5 meters sideways clearance during positioning
— 0.25 meters vertical clearance between the underside of the object and the top of the substructure during positioning
— 0.5 meters vessel under-keel clearance. (If the substructure has underwater elements limiting the water depth).

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

404 Adequate clearances shall be ensured between object or vessel(s) and the substructure shout be ensured throughout positioning, load transfer and removal of vessel(s).

Guidance note:

Contact (i.e. zero clearance) between the vessel(s) and protected (i.e. by fenders/bumpers) parts of the substructure is allowed if properly planned for. See E402. The effect of friction between vessel(s) and fenders should be considered.

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

405 Transport vessel(s) may get a relative (to the mated object) trim/heel during the final phase of the load transfer. Clearances at the support points shall be adequate to handle such relative trim/heel.

Guidance note:

Normally the transport vessel(s) should be ballasted to minimize the relative trim/heel.

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

F 500 Monitoring and monitoring systems

501 The following parameters should be monitored manually or by monitoring systems, see Section 2 D400, during mating operations:

— Relative position, orientation, and clearances of substructure and object prior to and during positioning.
— Clearances between vessel-object supports.
— Environmental conditions (monitoring should begin well in advance of the operation).
— Seabed clearances.
— The vessel's

  — water level in tanks

  - air pressure in compartments, if applicable
  - open/closed status for valves
  - trim, heel and draught.

- The substructure's

  - water level in cells/tanks
  - air pressure in cells/tanks
  - open/closed status for valves
  - leakages
  - heel, trim and draught
  - submergence rate and motions.

Guidance note 1:

Normally a remote reading sounding system should be used for tank water level control. A back-up system but not necessarily remotely controlled (e.g. measuring ullages by hand) should be provided.

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

Guidance note 2:

Support reaction measurements and comparison of the results with the actual vessel(s) and substructure ballast situation should be performed continuously during the mating. The actual deviation in total load and moments should be noted for each measurement and compared with agreed tolerances.

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

SECTION 7
OTHER LOAD TRANSFER OPERATIONS

A. General

A 100 Introduction

101 This section gives advice on how to consider other load transfer operations than the operations covered in section 3 to 6 in this standard.

A 200 Application

201 The requirements in Section 2 generally apply to all kinds of load transfer operations.

Guidance note:

The requirements to any load transfer operation shall be based on the requirements in this standard. If any doubt, it is recommended to clarify the interpretation of requirements with DNV.

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

202 It shall be considered if additional specific requirements are applicable based on the general requirements given in DNV-OS-H101.

A 300 Operation class

301 An operation class should, as for loadout see Section 3 A200, be defined according to Table 7-1.

Table 7-1 Operation class definition

Tide range	*Tide restrictions*	*Weather restrictions*	*Operation Class*
Significant	Yes	No/Yes	1
Significant	No	Yes	2
Significant	No	No	3
Zero	No	Yes	4
Zero	No	No	5

A 400 Ballasting systems

401 The capacity- and redundancy requirements to the ballasting system shall be based on the operation class. See Section 2 B.

A 500 Positioning systems

501 A positioning system ensuring accurate, i.e. within the specified tolerances, and safe guidance and positioning of the object/vessel(s) shall be provided.

502 Applicable design loads due to inertia (impact), live loads (e.g. maximum winch pull) wind, current, waves, etc. both in ULS and ALS should be defined for all parts (winches, wires, jacks, fenders, etc.) of the positioning system.

503 The design loads shall be defined based on all phases of the positioning.

504 Adequate resistance (safety factors) of all parts of the positioning system shall be documented.

505 Redundancy and back-up requirements to the positioning system shall be based on the Operation Class. See Table 7-2.

Table 7-2 Positioning system requirements

Operation Class	*The positioning system shall fulfil the following main requirements:*
1	— The design loads (see 502) shall be multiplied with a consequence factor of 1.3. — Reversing of the operation shall be possible. — ALS fulfilled for any single failure. — The positioning could be completed without significant delay after a single failure in the system.
2	— Reversing of the operation shall be possible. — ALS fulfilled for any single failure. — The positioning could be completed without more than 2 hours delay after a single failure in the system.

Table 7-2 Positioning system requirements (Continued)	
Operation Class	*The positioning system shall fulfil the following main requirements:*
3	— ALS fulfilled for any single failure.
4	— Reversing of the operation shall be possible. — ALS fulfilled for any single failure. — The positioning could be completed without more than 6 hours delay after a single failure in the system.
5	— No critical damages and the object/vessel(s) remain in a stable condition after a single failure in the system.
Notes: a) Fulfilment of ALS means; 1) no unacceptable damages and 2) the operation could be completed or the object/vessel(s) brought to a safe condition within the available operation period. b) If the requirement to reversing of the operation is not possible to fulfil throughout the operation the point of no return should be clearly defined.	

B. Float-over

B 100 General

101 A float-over operation is a mating of a vessel transported object onto a fixed structure, e.g. a platform substructure or construction supports. Hence, the requirements in Section 6 shall be considered and applied as found relevant.

102 A float-over could also be regarded as a reversed lift-off. Hence, the requirements in Section 5 shall be considered and applied as found relevant.

103 For offshore float-over operations special precautions need to be applied. These are outlined in B 200 to B 500 below.

B 200 Planning of offshore float-over

201 Strict environmental limitations normally apply for a float-over. Such conditions could be difficult to obtain offshore and this should be duly considered in the planning.

202 The planned operational time (T_{POP}) should be as short as practical possible, and if relevant the point of no return should be clearly defined. (See DNV-OS-H101 Section 2 A203)

B 300 Analysis and structures

301 Wave loads and motions due to waves shall be considered for mooring-, guide- and support reaction load calculations. See also Section 6 C200.

302 An adequate analysis model and method shall be used to establish both horizontal and vertical dynamic (impact) reaction loads during the positioning- and load transfer phases.

Guidance note:

It is recommended that the motions of the transport vessel (barge) and associated docking, mooring line and fender loads are analysed in the time domain for docking, load transfer, and undocking positions. Non-linear effects shall be considered.

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

303 The stiffness of the mooring system should be taken into account in the motion response analysis.

B 400 Systems

401 For positioning systems it should be considered to incorporate damping systems in order to control motions and potential impact loads.

402 Shock absorbers and leg mating units (LMUs) shall be included between the object and the (fixed/floating) structure. It shall be documented that the selected LMUs will adequately dampen the maximum expected vertical and horizontal motions.

403 If a jacking system enabling fast load transfer is applied detailed HAZID(s) of the system shall be carried out. The following should be adequately documented:

a) System strength, capacity and control means.

b) Stability and restraint of the structure.

c) Redundancy against single failures in the system.

404 The primary tank sounding system shall be capable of continuously monitoring in all tanks simultaneously. It should be possible to take all readouts at one single location, i.e. normally in the ballast control room.

B 500 Operational aspects

501 For offshore float-over a level A weather forecast should be provided, see DNV-OS-H101, Section 4 C200.

502 Adequate clearances shall be defined considering maximum expected motions, applied positioning system, and provided fendering/guiding.

503 A system for controlling the clearances and support loads during the operation should be established.

504 Motions shall be controlled by monitoring before and during the operation. Action(s) to be taken if the motions exceed the maximum expected motions shall be defined.

505 Adequate freeboard to avoid green water shall be ensured for all phases of the operation.

506 There will be a tendency to re-contact between transport vessel and object as they start to separate. Mitigations to avoid damages shall be considered.

C. Inshore Docking

C 100 General

101 This section gives advice on how to consider inshore docking operations. Docking is in this section defined as the positioning and setting of a floating object on under bottom supports.

Guidance note:

The requirements in this section should be considered both for docking onto supports placed on the seabed and supports placed on a floating vessel, e.g. submersible barge, HLV, floating dock.

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

102 For specific requirements to docking (loading) onto a floating vessel (e.g. HLV) see DNV-OS-H202.

103 Offshore positioning and setting, including docking, are described in DNV-OS-H204. Hence, the requirements in that standard shall be considered and applied as found relevant.

C 200 Under bottom supports

201 The design-, construction- and inspection of the under bottom supports shall be carried out according to recognized code(s) or standard(s). (See e.g. DNV-OS-H101, Section 1 B305).

202 For requirements to seabed supports see Section 3 G100.

203 Adequate stability of the object on the bottom supports shall be documented. This is particular relevant for docking of objects with a rounded type bottom onto a floating vessel.

C 300 Positioning and guidance system(s)

301 A system ensuring accurate, i.e. within the specified tolerances, and safe positioning of the object shall be provided. (See also Section 6 E400)

302 Required redundancy of the positioning system shall be based on the operation class. See Table 7-2 for guidelines.

C 400 Operational aspects

401 If no wave load analysis, see B300, has been carried out operational limiting criteria ensuring insignificant motions should be applied.

Guidance note:

The following is normally applicable as limiting criteria:

— zero (insignificant) swell
— significant wave height, Hs ≤ 0.5 meters.

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

SECTION 8
CONSTRUCTION AFLOAT

A. General

A 100 Application

101 This section applies for marine aspects related to the construction phase of self-floating structures.

A 200 Planning and design basis

201 General requirements are given in Section 2 A100.

202 Adequate protection of the structure against impact loads from dropped objects and vessel(s) used during the construction should be provided.

203 Sufficient freeboard to any open compartment should be ensured during all stages of construction considering the crest height of the design wave for the operation in question and the consequences for accidental flooding. For special operations, e.g. mating where the reserve buoyancy is very small, any open compartment should preferably be temporarily closed.

204 During heavy ballasting, slip forming and installation or transfer of heavy loads, special attention should be paid to hydrostatic stability and adjustment of moorings, see also C.

205 Adequate watertight integrity should be ensured at all stages during construction, see DNV-OS-H101 Section 5 A300.

206 Where valves are provided at watertight boundaries to provide watertight integrity, these valves should be capable of being operated from the bulkhead deck or weather deck, pump room, or other normally manned place. Valve positioned indicators should be provided at the remote control station.

207 All inlets should be adequately protected to prevent damage by entering debris and cables. All internal compartments should be cleared of debris before commencement of an immersion operation.

208 Systems and equipment to be used in the marine operations during construction should be specified to such a detail that complete assessment of the operational feasibility is rendered possible. An adequate emergency pumping system should be provided. The general requirements given in DNV-OS-H101 Section 6 A should be complied with.

B. Loads

B 100 General

101 The loads given in Section 4 B should be considered during construction afloat.

102 Adequate approved precautions (guides, bumpers, reduction of ballast rate, etc.) should be taken to avoid damages due to impact loads.

C. Stability Afloat

C 100 General

101 Requirements to stability afloat are given in DNV-OS-H101 Section 5 C.

102 Due attention shall be paid to that weight, buoyancy, CoG and CoB change continuously during the construction.

C 200 Inclining tests

201 Inclining tests should normally be performed at different stages during construction of floating structures in order to assess the position of the centre of gravity. This is particularly relevant when the calculated value of the metacentric height is close to the minimum value and if such a minimum condition is obtained by the transfer of heavy loads.

202 Inclining tests for the substructure should normally be performed both prior to major tows and prior to mating, see DNV-OS-H101 Section 5 A500.

D. Mooring

D 100 General

101 The requirements in DNV-OS-H101 Section 6 B apply.

102 The position of the moored structure should be checked with regard to permanent displacements, particularly in the first period after installation and after extreme weather conditions.

103 The penetration depth of direct-embedment anchors should be verified after the installation.

D 200 Anchor lines

201 The anchor lines used for long time mooring during construction afloat should have a documented minimum quality, see the guidance note below.

Guidance note:

Chain cables should comply with the requirements in DNV-OS-E302. Steel wire ropes should comply with the requirements in DNV-OS-E304.

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

202 The strength of the connecting link for combined chain and wire systems should not be inferior to the strength of the anchor line.

D 300 Auxiliary anchoring equipment

301 Anchoring equipment should be manufactured and tested according to DNV-OS-E301 Section 4.

302 Normally, the total breaking capacity of the windlass should not be less than the required strength of the anchor line.

303 Cable lifters should have sufficient diameter and be so designed that unfavourable chain stresses are avoided. Cable lifters should normally be of cast steel but ferritic nodular cast iron may also be considered.

304 Chain and wire stoppers should be of a design which does not bring unfavourable stresses upon the chain or wire.

305 Possible arrangement for emergency release of anchor lines should be considered in each case.

306 Fairleads fitted between the stopper and the anchor should be of the roller type and have swivel provisions.

307 The fairlead diameter should be sufficiently large and the design should be such that unfavourable stresses in the anchor line are avoided.

308 Compensators based on steel springs, hydraulic/pneumatic spring systems, fibre ropes over sheaves, etc., may be used.

309 The compensator should be of safe design and certified materials. Possible standard components used should be manufactured and tested according to recognised codes.

E. Operational Aspects

E 100 General

Operational requirements are generally described in DNV-OS-H101, Section 4. See also Section 2 D.