GL Noble Denton

TECHNICAL STANDARDS COMMITTEE

GUIDELINES FOR LOAD-OUTS

0013/ND

This document has been replaced by the standard DNVGL-ST-N001 which may be accessed through https://my.dnvgl.com/

This document may still be valid for some existing projects.

This Guideline was updated as part of the first stage of the harmonisation between the GL Noble Denton and DNV heritage marine services requirements.

Refer also to DNVGL-SE-0080 Noble Denton marine services – Marine Warranty Survey for further details.

All references to GL Noble Denton apply to the legal entity trading under the DNV GL or GL Noble Denton name which is contracted to carry out the scope of work and issues a Certificate of Approval, or provides a marine related advisory or assurance service.

Once downloaded this document becomes UNCONTROLLED.

28 Jun 16	8.1	RLJ	Replaced by DNVGL-ST-N001
14 Dec 15	8	MJR	Technical Standards Committee
22 Jun 13	7	MJR	Technical Policy Board
6 Dec 10	6	GPB	Technical Policy Board
31 Mar 10	5	GPB	Technical Policy Board
19 Jan 09	4	GPB	Technical Policy Board
01 Dec 04	3	JR	Technical Policy Board
01 Apr 02	2	JR	Technical Policy Board
07 Jul 93	1	JR	Technical Policy Board
16 Oct 86	0	JR	Technical Policy Board
Date	**Revision**	**Prepared by**	**Authorised by**

PREFACE

This document has been drawn with care to address what are considered to be the primary issues in relation to the contents based on the experience of the GL Noble Denton Group of Companies ("the Group"). This should not, however, be taken to mean that this document deals comprehensively with all of the issues which will need to be addressed or even, where a particular matter is addressed, that this document sets out a definitive view for all situations. In using this document, it should be treated as giving guidelines for sound and prudent practice, but guidelines must be reviewed in each particular case by the responsible organisation in each project to ensure that the particular circumstances of that project are addressed in a way which is adequate and appropriate to ensure that the overall guidance given is sound and comprehensive.

Reasonable precaution has been taken in the preparation of this document to seek to ensure that the content is correct and error free. However, no company in the Group

- shall be liable for any loss or damage incurred resulting from the use of the information contained herein or
- shall voluntarily assume a responsibility in tort to any party or
- shall owe a duty of care to any party other than to its contracting customer entity (subject always to the terms of contract between such Group company and subcontracting customer entity).

This document must be read in its entirety and is subject to any assumptions and qualifications expressed therein as well as in any other relevant communications by the Group in connection with it. Elements of this document contain detailed technical data which is intended for analysis only by persons possessing requisite expertise in its subject matter.

CONTENTS

1 SUMMARY

1.1 These Guidelines have been developed for the load-out of structures including offshore jackets, SPAR sections, modules, bridges and topside components from the shore onto floating or grounded barges and ships.

1.2 The principles of these Guidelines can also be applied to the load-in of structures onto the shore from a floating vessel /barge.

1.2.1 This document supersedes the previous revision, document 0013/ND Rev 7 dated 22 June 2013. The main change relates to the definition of load-out classes. Further changes are listed in Section 2.2.7. 8

1.3 These Guidelines are intended to lead to an approval by GL Noble Denton, which may be sought where an operation is the subject of an insurance warranty, or where an independent third party review is required.

1.4 A description of the Approval Process is included, for those projects which are the subject of an insurance warranty.

1.5 This document includes the requirements for consideration, intended to represent sound practice, for the structure to be loaded, load-out site, link beams and skidways, trailers, pumping and ballasting, jacking systems and winches, grounded load-outs, transverse load-outs, moorings, seafastenings, tugs and weather forecasts.

1.6 Methods for lifted load-outs are derived from GL Noble Denton's 0027/ND "Guidelines for Marine Lifting & Lowering Operations", Ref. [2].

1.7 Check lists are appended, to act as a guide to information required.

2 INTRODUCTION

2.1 SCOPE

2.1.1 This document refers to the transfer of a cargo onto a barge or vessel by horizontal movement or by lifting, including structures such as offshore jackets, SPAR sections, modules, bridges and topside components. It contains general recommendations and checklists of information required to allow approval of such operations by GL Noble Denton. Load-out of electrical cables is covered in “Guidelines for Offshore Wind Farm Infrastructure Installation”, 0035/ND, Ref. [5]

2.1.2 The guidelines and calculation methods set out in this document represent the views of GL Noble Denton and are considered sound and in accordance with offshore industry practice. Operators should also consider national and local regulations, which may be more stringent.

2.1.3 Due to the wide range of load-out and load-in methods, this document cannot cover all aspects of every load-out or load-in scheme. Alternative proposals and methods will be considered on their own merits, and can be approved if they are shown to be in accordance with safe practice.

2.1.4 This document applies particularly to skidded and trailered floating load-outs, in tidal waters. The varying requirements for grounded load-outs, or load-outs accomplished by lifting are also included. Reference to a 'barge' includes a 'ship' or a 'vessel' as applicable.

2.1.5 For lifted load-outs, the factors to be applied to rigging arrangements, lift points and structure may be derived from the latest revision of GL Noble Denton 0027/ND “Guidelines for Marine Lifting & Lowering Operations”, Ref. [2]. It should be noted that Ref. [2], although aimed primarily at offshore lifting operations, also includes methods and factors for lifts by floating cranes inshore, and for load-outs by shore-mounted cranes.

2.1.6 These guidelines are intended to lead to an approval by GL Noble Denton. Such approval does not imply that approval by designers, regulatory bodies and/or any other party would be given.

2.2 REVISIONS

2.2.1 Revision 2 dated 1 April 2002 superseded and replaced the previous Revision 1 dated 7 July 1993. Changes introduced in Revision 2 included:

- The inclusion of a Definitions Section
- Expansion of the Section on Limitation of Approval
- The introduction of the concept of classes of load-out, depending primarily on the tidal conditions
- Reference to the Draft ISO Standard on Weight Control
- Relaxation of under-keel clearance requirements.
- Expansion of the Section on Moorings
- Relationship of pumping requirements to the load-out class
- Relationship of propulsion, braking and pull-back system requirements to the load-out class
- Limited allowance of friction for temporary seafastenings
- Reformatting and Section renumbering as necessary.

2.2.2 Revision 3 superseded and replaced Revision 2. Changes included:

- Classes of load-out reduced from 6 classes to 5 (Sections 5, 13 and 15.7)
- Reference to the ISO weight control standard, to reflect the change from a Draft to a published Standard (Section 6.2)
- Introduction of stability considerations for floating barges (Section 8.2)
- Reference to GL Noble Denton’s transportation guidelines, for post-load-out stability (Section 8.2.2)
- Consideration of stability of hydraulic trailer systems (Section 13.2.2)
- Introduction of a new section on transverse load-outs (Section 17)

- Modifications to the loading definition and stress levels for barge movements following load-out (Sections 18.2 and 18.4)
- Minor changes to the checklist of information required for approval (Appendix A)
- Deletion of the previous flow chart for lifted load-outs (previous Appendix B), which can be obtained from GL Noble Denton's 0027/ND Lifting guidelines, Ref. [2].

2.2.3 Revision 4 superseded and replaced Revision 3. Changes included:

- Additions of Sections 1.2, 4.5.5, 4.6, 6.2.6 to 6.2.8, 10.9, 11.10 to 11.12, 14.1.4, 14.3, 15.11, 16.5, 17.5 and 16.7.
- Additions and revision to some Definitions.
- Change in the one third overload allowance in Sections 6.1.9 to 6.2.
- Addition of requirements for site moves and trailer path grading (Section 7.3).
- Skidway line and level documentation (Section 9.7) and Sections 9.8 and 9.9 added.
- Additional safety factor included for single line failure mooring cases (Sections 10.4 and 10.5).
- Additional requirements for lifted load-outs (Sections 16.2, 16.3, and 16.4).
- Addition of tug inspection (Section 19.3).
- Removal of Section 12.9 and the addition of an example for pumping system requirements in Section 13.11.

2.2.4 Revision 5 superseded and replaced Revision 4. Significant changes included:

- Text in Sections 2.1.1 and 2.1.2 amended
- Definitions (Barge, Insurance Warranty, IACS, Load-out, NDT, Survey, Surveyor, Vessel, Weather Restricted Operation, and Weather Unrestricted Operations) in Section 3 revised.
- Text in Section 4.2 revised to state load-out.
- Link beam adequacy in Section 11.1.included.
- Skidway tolerances included in Section 6.1.8.
- 1% load cell accuracy deleted from Section 6.2.5.
- Class reinstatement added in Section 8.1.4 and Section 18.7 included.
- Grounding pad area and depth added to Section 12.1.
- Text added in Section 13.2.2 for stability of trailers with 3-point support.
- Text in Section 15.3 and Table 15-1 for Class 2 skidded load-out pull-back and braking, requirements changed from "Required" to "Recommended". Slope changed to gradient.
- Weight and CoG tolerances included in Section 17.6.
- Requirements for weight reports and weighing enhanced in Section A.2.2 below.
- Link beam construction reports added in Section A.3.8.
- Reference to IACS for rigging added in Section A.8.8 and Section A.10.4.

2.2.5 Revision 6 superseded and replaced Revision 5. The only significant changes were in the Mooring Sections 10.2 to 10.8 which included the new 0032/ND "Guidelines for Moorings", Ref [4], and the inclusion of a new Section 8.3 on barge freeboard.

2.2.6 Revision 7 superseded and replaced Revision 6. The main changes are

- Reference to "Guidelines for Offshore Wind Farm Infrastructure Installation", 0035/ND, Ref. [5] for load-out of power cables in Section 2.1.1.
- the Seastate Reduction Factors have been updated, renamed "Metocean Reduction Factors" and moved from Section 10.2 to Section 7.3 of 0001/ND, "General Guidelines for Marine Projects", Ref. [1].
- Text from Sections 4 (The Approval Process), 6 (Structure to be Loaded) and 20 (Management and Organisation) has also been moved to Ref. [1].
- SLS and ULS limit states are replaced with LS1 (gravity dominated) and LS2 (environmental load dominated) in Sections 3, 6.1.10 and 18.4.
- Safety during Load-out has been moved from Section 4.4 to Section 20.1 and now refers to Ref. [1].
- Further guidance on ground strength in Section 7.1.
- Mooring guidance moved from Section 10 to Section 11 and 0032/ND "Guidelines for Moorings", Ref.[4].
- Trailer stability requirements changes in Section 14.2.

2.2.7 This Revision 8 supersedes and replaces Revision 7. The main changes, marked with a vertical line in the right hand margin, are

- Definitions updated in Section 3.1
- Classes of Load-Out updated in Section 5 to include weather restricted and weather unrestricted operations.
- Loads on structure from trailers / SPMTs clarified in Sections 6.1.3 - 6.1.5
- Effect of structural deflections during load out clarified in Section
- Load out path width clarified in Sections 7.1.17.1.2 and 7.3.1
- Barge freeboard clarified in Sections 8.3.1 and 8.3.2.
- New Section 10.3 for weather unrestricted operations.
- Loads on moorings updated in Section 11.1
- Requirements for grounded load outs clarified in Sections 12.2, 12.3 and 12.5.
- Pumping requirements updated in Section 13.1, Table 13-1 and Table 13-2
- Ballast tank capacity requirements added in new Section 13.12 and new Table 13-3. 8
- Requirements for ramp comprised of steel plates added in new Section 14.1.5.
- Stability check requirments updated in Section 14.2.
- Requirements for set up of SPMT steering coordinates added in new Section 14.2.12 and added to A.5.8
- Propulsion, system capacity and friction requirements updated in Sections 15.7 to 15.13, Section 15.15, Table 15-1 and Table 15-2.
- Barge reinstatement requirements updated in Sections 18.2 and 18.3.

2.3 DOWNLOADS & FEEDBACK

2.3.1 Electronic versions of GL Noble Denton Guidelines are available on:

https://www.dnvgl.com/rules-standards/noble-denton-maa-rules-and-guidelines.html

Care should be taken when referring to any GL Noble Denton Guideline document that the latest revision is being consulted.

2.3.2 Please contact the Technical Standards Committee Secretary at TSC@dnvgl.com with any queries or feedback.

3 DEFINITIONS

3.1 Referenced definitions are underlined.

Term or Acronym	Definition	
Alpha Factor	The maximum ratio of operational criteria / design environmental condition to allow for weather forecasting inaccuracies. See Section 7.4.8 of 0001/ND, Ref. [1].	
Approval	The act, by the designated GL Noble Denton representative, of issuing a Certificate of Approval.	
ASD	Allowable Stress Design (effectively the same as WSD)	
Barge	A non-propelled vessel commonly used to carry cargo or equipment. (For the purposes of this document, the term Barge can be considered to include Pontoon, Ship or Vessel where appropriate).	
Certificate of Approval	A formal document issued by GL Noble Denton stating that, in its judgement and opinion, all reasonable checks, preparations and precautions have been taken to keep risks within acceptable limits, and an operation may proceed.	
Competent person	Someone who has sufficient training and experience or knowledge and other qualities that allow them to assist you properly. The level of competence required will depend on the complexity of the situation and the particular help required. For further details, refer to Section 15.1.2 of 0027/ND, Ref.[2].	
Freeboard	Freeboard is defined as the distance from the waterline to the watertight deck level. In commercial vessels, it is measured relative to the ship's load line. Effective freeboard is the minimum vertical distance from the still water surface to any opening (e.g. an open manhole) or downflooding point, after accounting for barge trim and heel.	8
GL Noble Denton	The legal entity trading under the DNV GL or GL Noble Denton name which is contracted to carry out the scope of work and issues a Certificate of Approval, or provides a marine related advisory or assurance service.	
Gradient	The angle over the distance between supports that the load-out skidway, barge deck and/or trailer load-out path makes with the horizontal plane.	
IACS	International Association of Classification Societies	
Insurance Warranty	A clause in the insurance policy for a particular venture, requiring the approval of a marine operation by a specified independent survey house.	8
Link beam / link span	The connecting beam between the quay and the barge or vessel. It may provide a structural connection, or be intended solely to provide a smooth path for skidshoes or trailers /SPMTs.	
Load-in	The transfer of a major assembly from a barge onto land by horizontal movement or by lifting.	
Load-out	The transfer of a major assembly onto a barge by horizontal movement or by lifting.	
Load-out Frame	A structural frame that supports the structure during fabrication and load-out and may support the structure on a barge/vessel to the site. May also be called a Module Support Frame (MSF).	

Term or Acronym	Definition
Load-out, floating	A Load-out onto a floating barge or vessel.
Load-out, grounded	A Load-out onto a grounded barge or vessel.
Load-out, lifted	A Load-out performed by crane.
Load-out, skidded	A Load-out where the Structure is skidded, using a combination of skidways, skidshoes or runners, propelled by jacks or winches.
Load-out, trailer	A Load-out where the Structure is wheeled onto the barge or vessel using Trailers or SPMTs.
LRFD	Load and Resistance Factor Design.
LS1 / Limit State 1	A design condition where the loading is gravity dominated; also used when the exclusions of Section 9.2.5 of 0001/ND, Ref. [1] apply.
LS2 / Limit State 2	A design condition where the loading is dominated by environmental / storm loads, e.g. at the 10- or 50-year return period level or, for weather restricted operations, where an Alpha factor according to Section 7.3.4 of 0001/ND, Ref. [1], is to be applied.
MHWS	Mean High Water on Spring Tides.
MLWS	Mean Low Water on Spring Tides.
MSF	Module Support Frame
NDT / Non Destructive Testing	Ultrasonic scanning, magnetic particle inspection, eddy current inspection or radiographic imaging or similar. May include visual inspection.
Operation Duration	The planned duration of the operation from the forecast prior to the Point of No Return to a condition when the operations /structures can safely withstand a seasonal design storm (also termed "safe to safe" duration); this excludes the contingency period.
Operational Reference Period	The Operation Duration, plus the contingency period
PNR / Point of No Return	The last point in time, or a geographical point along a route, at which an operation could be aborted and returned to a safe condition
RCS / Recognized Classification Society	Member IACS with recognized and relevant competence and experience in specialised vessels or structures, and with established rules and procedures for classification / certification of such vessels /structures under consideration.
Seafastenings	The means of restraining movement of the loaded structure on or within the barge or vessel
Site Move	An operation to move a structure or partially assembled structure in the yard from one location to another. The site move may precede a load-out if carried out as a separate operation or may form part of a load-out. The site move may be subject to approval if so desired.
Skidshoe	A bearing pad attached to the Structure which engages in the Skidway and carries a share of the vertical load.
Skidway	The lower continuous rails, either on the quay or on the barge, on which the Structure is loaded out, via the Skidshoes.
SPMT	Self-Propelled Modular Transporter – a trailer system having its own integral propulsion, steering, jacking, control and power systems.

Term or Acronym	Definition
Structure	The object to be loaded out
Surge	A change in water level caused by meteorological conditions
Survey	Attendance and inspection by a GL Noble Denton representative. Other surveys which may be required for a marine operation, including suitability, dimensional, structural, navigational and Class surveys.
Surveyor	The GL Noble Denton representative carrying out a survey. An employee of a contractor or Classification Society performing, for instance, a suitability, dimensional, structural, navigational, or Class survey.
SWL / Safe Working Load	SWL is a derated value of WLL, following an assessment by a competent person of the maximum static load the item can sustain under the conditions in which the item is being used.
Tidal Range	Where practicable, the tidal range referred to in this document is the predicted tidal range corrected by location-specific tide readings obtained for a period of not less than one lunar cycle before the operation.
Trailer	A system of steerable wheels, connected to a central spine beam by hydraulic suspension which can be raised or lowered. Trailer modules can be connected together and controlled as a single unit. Trailers generally have no integral propulsion system, and are propelled by tractors or winches. See also SPMT.
Vessel	A marine craft designed for the purpose of transportation by sea or construction activities offshore. See Barge
Weather restricted operation	A marine operation which can be completed **within the limits** of an operational reference period with a weather forecast not exceeding the operational criteria. The operational reference period (which includes contingencies) is generally less than 72 hours. The design environmental condition need not reflect the statistical extremes for the area and season. An alpha factor shall be accounted for in defining the design environmental condition. See Section 7.4.8 of 0001/ND, Ref. [1].
Weather unrestricted operation	An operation with an operational reference period **greater than** the reliable limits of a weather forecast. The operational reference period (which includes contingencies) is generally more than 72 hours. The design weather conditions must reflect the statistical extremes for the area and season. The design weather is defined in Section 7.3 of 001/ND, Ref. [1]. 1
WLL / Working Load Limit	The maximum force which a product is authorized to sustain in general service when the rigging and connection arrangements are in accordance with the design. See SWL.
WSD	Working Stress Design (effectively the same as ASD)

4 THE APPROVAL PROCESS

4.1 GL NOBLE DENTON APPROVAL

4.1.1 Further information on the approval process appears in DNVGL-SE-0080 - Noble Denton marine services – Marine Warranty Survey, Ref [6].

4.2 SCOPE OF WORK LEADING TO AN APPROVAL

4.2.1 In order to issue a Certificate of Approval for a load-out, GL Noble Denton will typically consider, as applicable, the topics and information listed in Appendix A.

4.2.2 Technical studies leading to the issue of a Certificate of Approval may consist of:

a. Reviews and audits of procedures and calculations submitted by the client or his contractors, or

b. Independent analyses carried out by GL Noble Denton to verify the feasibility of the proposals, or

c. A combination of third party reviews and independent analyses.

4.2.3 Surveys required typically include preliminary surveys of the barge, structure and site; attendance at load-out meetings; surveys of readiness to start load-out and witnessing of load-out operation.

4.3 LIMITATION OF APPROVAL

4.3.1 The following limitations are in addition to those in DNVGL-SE-0080 - Noble Denton marine services – Marine Warranty Survey, Ref [6].

4.3.2 A Certificate of Approval for a load-out covers the marine operations involved in the load-out only. Load-out is normally deemed to start at the time when the structure is either moved from its construction support(s) or the structure first crosses the edge of the quay or link beam. It is normally deemed to be completed at the end of the marine operations forming part of the load-out, including set down on the barge, completion of required initial seafastening to turn the barge, and turning the barge back to the quay if carried out on the same tide as load-out.

4.3.3 A Certificate of Approval for a load-in covers the marine operations involved in the load-in only. Load-in is normally deemed to start at the time when the structure is moved from its barge grillage support(s), and all barge ballasting and mooring activities are complete. It is normally deemed to be completed at the end of the operations forming part of the load-in procedure, including set down on the shore supports.

5 CLASSES OF LOAD-OUT

The load-out operation will be classed according to the tidal conditions and whether it is a weather restricted operation or a weather unrestricted operation. Requirements for design, reserves and redundancy of mechanical systems will vary according to the class of load-out. Sub notations declaring if the load-out is to be weather restricted operation or weather unrestricted operation shall be as per Table 5-2.

Table 5-1 Load-out Classes

Class	Tidal Limitations
1	The tidal range is such that regardless of the pumping capacity provided, it is not possible to maintain the barge level with the quay throughout the full tidal cycle, and the load-out must be completed within a defined tidal window, generally on a rising tide.
2	The tidal range is such that whilst significant pumping capacity is required, it is possible to maintain the barge level with the quay during the full spring tidal cycle, and for at least 24 hours thereafter.
3	Tidal range is negligible or zero, and there are no tidal constraints on load-out. Pumping is required only to compensate for weight changes as the load-out proceeds.
4	Grounded load-out, with tidal range requiring pumping to maintain ground reaction and/or barge loading within acceptable limits.
5	Grounded load-out requiring no pumping to maintain ground reaction and/or barge loading within acceptable limits.

8

Table 5-2 Sub-Notation for Weather Limitations

Weather Limitations	Sub-Notation
Weather Restricted	a
Weather Unrestricted Operations	b

6 STRUCTURE TO BE LOADED

6.1 DESIGN

6.1.1 The item to be loaded, hereafter called the 'structure', shall be designed taking into account static and dynamic loads, support conditions, environmental loads and loads due to misalignment of the barge and shore skidways or uneven ballasting.

6.1.2 For skidded load-outs, analyses which account for the structure and skidway should be presented which consider the elasticity, alignment and as-built dimensions of the shore and barge skidways for each stage of load-out. In the absence of detailed information, a 75/25 percent distribution of load across either diagonal may be considered as appropriate.

6.1.3 For trailer or SPMT load-outs, the reactions imposed by the trailer configuration shall be considered. When checking the structure, it cannot be assumed that the SPMTs reactions at each support will be as determined from a structural analysis using rigid supports. This is because each SPMT group is a pressurised system (which gives equal loading of the SPMT axles in that group) and the reactions at the SPMT/Structure interface are dependent on the stiffness, axle arrangement and grouping of the SPMT. Where reactions from the SPMTs are shown to locally overload certain members in the structure, then consideration can be given to locking off the wheels local to the support location so they are inactive or to use differential shimming heights at the support location to reduce the loads in the overloaded members. When such load redistribution is adopted, the effect of increased reactions at other supports shall be assessed.

6.1.4 For SPMT load-outs using 4 support groups the effect of skew loading across diagonals shall be assessed to account for the possibility that the groupings may not be coplanar due to incorrect pressure in the SPMT groups, the stiffness of the structure and uneven conditions beneath the SPMTs. The 8
measured load (i.e. pressure) variation across a diagonal should not exceed 20% of the combined nominal value for that diagonal and the maximum variation for an individual group should not exceed 25% of the nominal value. The structure shall be checked to ensure these limitations do not cause overstress.

6.1.5 For a 3 point support system using SPMTs, the effect of skew across a diagonal and the associated increase in load on an individual group, as described in 6.1.4, does not need to be considered in the design of the structure.

6.1.6 During all operations, the hydraulic pressure readings shall be continually monitored to ensure that the design limitations are not exceeded. The accuracy of the readings shall be taken into account. Additionally, the deflection of the structure shall be monitored to ensure that there are no excessive deflections.

6.1.7 For lifted load-outs, the structure, including the padeyes, shall be analysed for the loads and reactions imposed during the lift, as set out in 0027/ND, Ref. [2].

6.1.8 The structure and supports shall be demonstrated as being capable of withstanding the subsidence of any single support with respect to the others by at least 25mm. Consideration shall also be given to lifting off construction supports or onto seafastening supports where these operations form an integral part of the load-out operation.

6.1.9 The primary structure shall be of high quality structural steelwork with full material certification and NDT inspection certificates showing appropriate levels of inspection. It shall be assessed using the methodology of a recognised and applicable offshore code including the associated load and resistance factors for LRFD codes or safety factors for ASD/WSD codes. Further details appear in Section 9.1 of 0001/ND, Ref. [1].

6.1.10 Except as allowed by Section 18.4, all load cases shall be treated as LS1, a gravity dominated limit state).

6.2 WEIGHT CONTROL

6.2.1 See Section 8 of 0001/ND, Ref. [1], for further information about weight control.

7 SITE AND QUAY

7.1 SITE CAPACITY

7.1.1 A statement shall be submitted showing the adequacy for the load-out of the quay, quay approaches, wall and foundations. This can be in the form of historical data or geotechnical and structural analyses. Checks on the route shall consider the overall width of the trailers/SPMTs plus a tolerance of at least 2 m either side. 8

7.1.2 When transporting structures that exert a relatively high bearing pressure on the ground, either:

- documentation shall show that the entire route, including the quayside, has safely withstood higher bearing pressures under similar loading conditions, or
- a specific analysis shall be performed for the entire route to determine that the bearing capacity of the ground is adequate to safely support the load being transported. The calculated bearing capacity of the ground shall exceed the applied bearing pressure from the transported structure /vehicle by an appropriate margin of safety (depending on the geotechnical conditions, type of loading and structural configuration).

This is particularly important for situations where equipment is being offloaded on un-compacted ground for the construction of a quay.

7.1.3 A statement shall be submitted showing the capacity of all mooring bollards, winches and other attachments to be used for the load-out.

7.1.4 Compatibility between quay strength and elasticity, and the support conditions used for analysis of the structure, shall be demonstrated where appropriate.

7.2 MARINE ASPECTS

7.2.1 Bathymetric information for the area covered or crossed by the barge during load-out, post-load-out operations and sailaway shall be supplied. Under-keel clearance shall not normally be less than 1.0 m during the period for which the barge is in position for load-out. This may be relaxed to 0.5 m, subject to confidence in the lowest predicted water levels, and provided a check of the load-out area has been made by bar sweep, divers' inspection or side-scan survey sufficiently recently to represent actual conditions at the time of load-out. Where there is a risk of debris reducing under-keel clearance, a sweep shall be made immediately prior to the barge berthing to ensure that no debris exists that could damage the barge keel plating. The results of the sweep shall be confirmed by further soundings check around the barge perimeter after barge berthing.

7.2.2 For tidal load-outs, an easily readable tide gauge shall be provided adjacent to the load-out quay in such a location that it will not be obscured during any stage of the load-out operation. Where the tide level is critical, the correct datum should be established.

7.2.3 Port authority approval for the operation should be obtained, and control of marine traffic instituted, as required.

7.3 LOAD-OUT PATH

7.3.1 The load-out path plus at least 2m either side shall be freshly graded prior to load-out, pot holes filled and compacted, debris removed and obstructions to the load-out path identified and removed. 8

7.3.2 Where a structure cannot be loaded out directly onto a barge or vessel without turning, turning radii shall be maximised where possible. For small turning radii, lateral supports /restraints shall be installed between the trailer and the structure /load-out frame /cribbage. It is possible that a site move may be part of the load-out operation.

8 BARGE

8.1 CLASS

8.1.1 The barge shall be classed by a recognised IACS Member. Alternatively, structural drawings and results of structural analyses shall be supplied to GL Noble Denton for review. Additional surveys may be required by GL Noble Denton.

8.1.2 The loads induced during load-out, including longitudinal bending, loads on internal structure and local loads, shall be checked to be within the approved design capabilities.

8.1.3 Mooring attachments and all attachments for jacking or winching shall be demonstrated to be adequate for the loads anticipated during or after load-out. See also Section 11.

8.1.4 Some load-out operations may temporarily invalidate the class or load line certificate (see Section 8.3.2), and it will be necessary for any items temporarily removed for load-out be reinstated after load-out. This may apply if, for instance, holes have been cut in the deck for ballasting, if towing connections have been removed or, in some instances, after grounding on a pad. In such cases the vessel must be brought back into class prior to sailaway. 8

8.1.5 **Submersible barges**. Barges that can be totally immersed in the intact condition should be classed as submersible barges. Submersible barges are normally classed as such by the RCS (Recognized Classification Society).

8.2 STABILITY

8.2.1 Barge stability shall be shown to be adequate throughout the load-out operation. Particular attention should be paid to:

- A load-out onto a barge with a small metacentric height, where an offset centre of gravity may induce a heel or trim as the structure transfer is completed – i.e. when any transverse moment ceases to be restrained by the shore skidways or trailers.
- A load-out where there is a significant friction force between the barge and the quay wall, contributed to by the reaction from the pull on system and the moorings. The friction may cause "hang-up" by resisting the heel or trim, until the pull-on reaction is released, or the friction force is overcome, whereupon a sudden change of heel or trim may result. (See also Section 15.5).
- Cases where a change of wind velocity may cause a significant change of heel or trim during the operation.

8.2.2 After the structure is fully on the barge, then stability should comply with the requirements of 0030/ND "Guidelines for Marine Transportations", Ref. [3] and those of the flag state.

8.3 BARGE FREEBOARD

8.3.1 The effective freeboard during the load-out shall always be greater than:

- 0.5 m plus 50% of the maximum wave height expected during the load-out operation if procedures are in place to monitor the freeboard at all four quarters of the barge, or. ,
- 0.8 m plus 50% of the maximum wave height expected during the load-out operation if no freeboard monitoring is implemented

The effective freeboard shall allow for the maximum possible tide level during the load-out operational reference period. The bunding of openings in the barge deck shall also be considered for low "effective freeboards". 8

8.3.2 Where the load line is exceeded, the minimum effective freeboard used during the operation shall be confirmed as acceptable by the vessel's class society and shall be sufficient to maintain the vessel's water-plane area.

9 LINK BEAMS, SKIDWAYS AND SKIDSHOES

9.1 Documentation including a statement showing the strength of the skidways, link beams and skid shoes shall be submitted, demonstrating compatibility with the statements made and assumptions used for the structural analysis.

9.2 Link beams shall be checked for loads induced by barge moorings, barge movements and pull on/pull back forces.

9.3 Tolerances on link beam movement shall be shown to be suitable for anticipated movements of the barge during the operation.

9.4 Where a barge, because of tidal limitations, has to be turned within the load-out tidal window the design of the link beams shall be such that when the loaded unit is in its final position they are not trapped, i.e. they are free for removal.

9.5 Suitable lateral guides shall be provided along the full length of skidways.

9.6 Sufficient articulation or flexibility of skid shoes shall be provided to compensate for level and slope changes when crossing from shore to barge.

9.7 The line and level of the skidways and skidshoes shall be documented by dimensional control surveys and reports. The line and level shall be within the tolerances defined for the load-out operation and skidway / skidshoe design.

9.8 For floating load-outs care shall be taken to ensure that minimum friction exists between the barge and quay face. Where the quay has a rendered face, steel plates shall be installed in way of the barge fendering system.

9.9 The interface between the barge and barge fendering shall be liberally lubricated with grease or other substitute which complies with local environmental rules.

10 METOCEAN / WEATHER CRITERIA

10.1 A load-out may normally be considered a weather restricted operation which is covered in Section 7.3 of Ref. [1], "General Guidelines for Marine Projects". Limiting weather conditions for the load-out operation shall be defined, taking into account:

- the forecast reliability for the area
- the operational reference period as defined in Section 3 8
- the exposure of the site
- the time required for any operations before or after the load-out operation including barge movements and moorings, ballasting, system testing, final positioning and initial seafastening
- currents during and following the operation, including blockage effects if applicable
- the wind area of the cargo and the barge/vessel.

10.2 Moorings that are required outside the weather restricted operation period shall be designed for the criteria in Section 7.2 of 0032/ND, Ref. [4].

10.3 A load-out may be considered a **weather unrestricted** operation. This may be beneficial if it could be difficult to perform the operation within a reasonable Operational Reference Period, e.g. if there are uncertainties regarding the applicable durations of contingencies. Such operations are typically in benign/sheltered areas where the year round wind, wave and current statistics are considered in any analysis or in areas where the seasonal conditions are suitable for weather unrestricted operations. In addition to the applicable items listed in Section 10.1, the following should be taken into account for a weather unrestricted operation:

- The selection of environmental conditions for load-out shall be in accordance with Section 7 of Ref. [1] using the operational reference period to determine the metocean return period.
- There should be no possibility for significant waves/swell in any weather conditions at the load-out quay. 8
- The vessel mooring in the load-out position and stability of the structure being loaded out on skid beams/trailers/SPMTs shall be checked for the unrestricted environmental conditions.
- A risk assessment shall show that all necessary task can be performed safely in the unrestricted environmental conditions.
- Seasonal variations of environmental conditions may be used where the operational reference period (including contingencies) is of limited duration.
- All wind velocities used shall include the effects of any squalls and/or thunder storms.
- The procedures should highlight metocean conditions/directions to which the operation is sensitive.

11 MOORINGS

11.1 Moorings for the load-out operation shall be designed for the limiting weather in combination with the
maximum loads from the pushing or pulling of the structure. The limiting weather is defined in Section 8
10. Maximum loads from pushing or pulling of structure shall be determined using the design
requirements in Section 15.

11.2 The analysis of environmental forces for the barge/vessel mooring arrangement, and the resulting design of the mooring system shall be carried out in accordance with 0032/ND "Guidelines for Moorings", Ref. [4].

11.3 Mooring prior to and after load-out shall normally be considered an unrestricted operation. If approval is required for such moorings, they shall normally be designed to the return periods given in Table 7-1 of 0001/ND, Ref. [1] and in accordance with 0032/ND, Ref. [4].

12 GROUNDED LOAD-OUTS

12.1 The plan area of the grounding pad with respect to the barge keel shall be of sufficient extent to ensure stability of the edges of the grounding pad. Geotechnical site investigation data shall be submitted together with geotechnical calculations demonstrating the capacity of the grounding pad.

12.2 A survey of levels over an area including the grounding pad shall be submitted, showing suitable support conditions for the barge. The survey shall also demonstrate that there are adequate clearances provided for any protruding elements on the underside of the barge (e.g. anodes and bilge keels).

12.3 A bar sweep or side-scan survey, supported by divers' inspection if appropriate, shall be made just 8
before positioning the barge, to ensure that no debris exists which could damage the barge bottom plating. When determining the loading on the barge bottom plating, the extreme low tide throughout the period the barge is grounded shall be considered.

12.4 If even support over the barge bottom plating cannot be achieved, then calculations shall be submitted showing that no overstress will occur.

12.5 The barge shall be ballasted to provide sufficient ground reaction to withstand loads due to the
applicable metocean conditions from Section 7.3 of Ref. [1], in both pre and post-load-out conditions, at 8
mean high water spring tide with the 10 year storm surge.

12.6 The barge should be positioned and ballasted onto the pad several tides before the load-out operation, to allow for consolidation and settlement; the number of tidal cycles required will depend on the preload applied and should be evaluated by geotechnical analysis. Barge levels should be monitored during this time.

12.7 Final skidway levels shall be compatible with assumptions used for structural analysis as in Sections 6.1.1 and 6.1.2.

12.8 The ballast shall be adjusted during load-out, if required, to avoid barge settlement or overstress.

12.9 A plan shall be prepared for the initial seafastening and float-off operation following completion of load-out.

12.10 Even when the barge is on the grounding pad, mooring lines between the barge and quayside shall be maintained.

12.11 Between load-out and sailaway, the barge keel shall be inspected, either by diver survey or internal tank inspection, in order to maintain the barge in class. Class surveyor attendance will be required.

12.12 The grounding pad elevation shall be defined based on the actual depth of the barge and not the moulded barge depth.

13 PUMPING AND BALLASTING

13.1 Pumping capacity shall be provided as given in Table 13-1, and is dependent on the Class of load-out as defined in Section 5, and to satisfy each Condition as defined below:

Condition A: Normal Operating Condition.
The pump capacity required for the normal operating condition. For Condition A, 100% pump capacity represents the nominal pump capacity required for the load-out at the planned speed (to compensate for tidal changes and weight transfer) with no contingencies.

Condition B: Contingency requirement, horizontal movement stopped.
The pump capacity required for the contingency condition of horizontal movement stopped. For Condition B, 100% pump capacity represents the nominal pump capacity to hold the barge level with the quay, at the maximum rate of a rising or falling tide.

Condition C: Contingency requirement, One Pump System Failed. 8
The pump capacity required, to continue the operation at the planned speed, at the maximum rate of a rising or falling tide, assuming the failure of any one pump, component or pumping system. Where two or more pumps are supplied from a common power source, this shall count as a single system. For Condition C, 100% pump capacity is the same nominal pump capacity as determined for Condition A.

Condition D: Contingency requirement, horizontal movement stopped and One Pump System Failed.
The pump capacity required for the contingency condition of horizontal movement stopped and the failure of any one pump, component or pumping system. Where two or more pumps are supplied from a common power source, this shall count as a single system. For Condition D, 100% pump capacity is the same nominal pump capacity as determined for Condition B.

13.2 Pump capacity shall be based on the published pump performance curves, taking account of the maximum head for the operation and pipeline losses.

13.3 Ideally, discrete ballast programmes should be prepared for tidal level, weight on barge and trim and heel corrections. Wherever possible, specific tanks should be dedicated to tidal compensation and the remaining tanks to weight compensation.

13.4 If the barge pumping system is used as either the primary system, back-up system or in a combined system, then a barge engineer familiar with the system shall be in attendance throughout the operation. The load-out communication system shall include the pump room.

13.5 All pumps and systems shall be tested and shown to be operational within 24 hours of the start of load-out. At the discretion of the GL Noble Denton surveyor, a verification of pump capacity may be required.

13.6 Pumps which require to be reversed in order to be considered as part of the back-up capacity shall be capable of such reversal within 10 minutes, and adequate resources shall be available to perform this operation.

13.7 Pumps which require to be moved around the barge in order to be considered as part of the back-up capacity, shall be easily transportable, and may only be so considered if free access is provided at all stages of load-out between the stations at which they may be required. Adequate resources shall be available to perform this operation.

13.8 Ballast and barge levels shall be monitored during load-out, and shown to be within the limits of movements of any link beams and the structural limitations of the barge and structure.

13.9 Where a compressed air system is used, the time lag needed to pressurise or de-pressurise a tank should be taken into account, as should any limitations on differential pressure across a bulkhead. It should be remembered that compressed air systems cannot always fill a tank beyond the external waterline.

13.10 When more onerous, a reasonable amount of residual water in the ballast tanks shall be taken into account. The residual water level should be determined accounting for the barge heel and trim and the elevation of the lowest pumping inlet/outlet. Where flow to the pumping inlet/outlet is restricted, the level should be taken as the top of the bottom plate stiffeners plus 0.05m.

Table 13-1 Required Pump Capacity

Load-out Class	Condition	Pump capacity required, as a percentage of nominal capacity for that condition
1a and 1b (Tidal window)	A	200% or 150% see note 1
	B	150%
	C	120%
	D	100%
2a (Constant deck level >24hrs, weather restricted)	A	130%
	B	150%
	C	100%
	D	100%
2b (Constant deck level >24hrs, weather unrestricted)	A	130%
	B	150%
	C	Contingency procedures – see note 2
	D	100%
3a (Little tide, weather restricted)	A	130%
	B	No requirements
	C	100%
	D	No requirements
3b (Little tide, weather unrestricted)	A	130%
	B	No requirements
	C	Contingency procedures– see note 2
	D	No requirements
4a and 4b (Grounded + pumping, weather restricted and unrestricted)	A	120%
	B	120%
	C	100%
	D	100%
5a and 5b (Grounded, weather restricted and unrestricted)	All	No requirements

8

Note 1: Pumping capacity to meet the requirement of the maximum of the following percentages:
150% of the nominal capacity for the condition where the structure is loaded out at the planned speed and the planned duration including contingencies is less than the tidal window duration.
200% of the nominal capacity for the condition where the structure is loaded out at a reduced speed with the combined duration for the reduced speed plus contingencies equal to the tidal window duration.

Note 2: The contingency procedure shall contain details covering pump system failure and the associated actions required to correct the pump system failure.

13.11 Table 13-2 gives an example for a Class 2a Load-out that assumes that the worst single system failure reduces the pumping capacity to 80% of the full capacity (with any consistent units).

Table 13-2 Example of required pumping capacity calculation

Condition	Nominal capacity	Factor	Required capacity
A	1,000	130%	1,300
B	1,100	150%	**1,650**
C	1,000 / 80% = 1,250	100%	1,250
D	1,100 / 80% = 1,375	100%	1,375
Required			**1,650** (Condition B)

13.12 The ballast tanks shall have adequate capacity to make it feasible to maintain the vessel at required draft, trim and heel throughout the load-out operation for both the planned ballasting sequence and for the contingency ballasting procedures. The required tank capacities should include relevant spare capacity to compensate for the following when considered with the conditions given in Table 13-3.

- Tide levels below or above the predicted values
- Vessel lightweight, including installed equipment, grillages, etc., higher or lower than expected
- Possible structure weight and CoG variations
- Possible variations in the weight of load-out equipment (e.g. trailers, skid shoes etc).

Table 13-3 Conditions for Ballast Tank Capacity

Load-out Class	Conditions for Ballast Tank Capacity
1a and 1b	• Normal Operation • Reversing the Operation • Tide Compensation if load-out is stopped considering maximum possible duration of load-out • All of the above including contingencies
2a	• Normal Operation • Ballasting through a complete tide cycle at any stage of the load-out. • Maximum tide variations within the load-out operation period including contingency time • Reversing the Operation • All of the above including contingencies
2b	• Normal Operation • Ballasting through a complete tide cycle at any stage of the load-out. • Maximum tide variations expected including for the next 3 to 5 days • Reversing the Operation • All of the above including contingencies
3a	• Normal Operation • Reversing the Operation • All of the above including contingencies
3b	• Normal Operation • Reversing the Operation • All of the above including contingencies
4a and 4b	• Normal Operation • Reversing the Operation • Tide Compensation if load-out is stopped considering maximum possible duration of load-out • All of the above including contingencies
5a and 5b	• Normal Operation • Reversing the Operation • All above including contingencies

8

14 LOAD-OUTS BY TRAILERS, SPMTS OR HYDRAULIC SKID-SHOES

14.1 STRUCTURAL CAPACITY

14.1.1 Maximum axle loading shall be shown to be within the trailer manufacturer's recommended limits.

14.1.2 "Footprint" pressure on the quayside, link beam and barge deck shall be shown to be within the allowable values.

14.1.3 Shear force and bending moment curves shall be prepared for the trailer spine structure, and maximum values shall be shown to be within the manufacturer's allowable figures.

14.1.4 Link span bridge capacity shall be demonstrated by calculation and these calculations shall form part of the load-out procedure.

14.1.5 Special caution/consideration should be given to steel plates used as a link span bridge between the quay and the barge. The following shall be considered when ensuring their suitability:

- barge ballasting should be carried out to minimise the difference in level between the barge deck and the quay
- the distance between the barge and the quay should be minimised to avoid excessive 8
  deformation of the steel plates caused by the reactions from the trailers or SPMTs.
- effectively maintaining of the barge position on the quay e.g. using mooring winches
- securing the plates to the barge or quay to prevent their slippage during load-out.

14.2 LOAD EQUALISATION & STABILITY

14.2.1 Stability of the hydraulic system to resist overturning shall be shown to be adequate, particularly when a 3-point hydraulic linkage system is proposed. Whilst a 3-point linkage system results in a determinate support system, a 3-point support system is generally less stable than a 4-point support system. Stability shall be documented for the system used. The minimum tipping angle shall be checked to meet the requirements of Sections 14.2.2 to 14.2.6 with guidance given in Section 14.2.7. 8

14.2.2 **Load case A.** The stability of the virtual centre of gravity location shall be checked to ensure that the minimum tipping angle when measured to the closest tipping line shall be a minimum of 7 degrees when considering the following:

1. the most extreme possible location of the horizontal and vertical centre of gravity,
2. when transiting on land, any known inclination of the route which cannot be compensated by levelling of the SPMTs, increased by 2 degrees to account for uncertainties in the route profile (i.e. a minimum of 2 degrees must be considered).
3. when transiting on a barge or bridge link, any predicted inclination of the barge and link under the design wind and ballast conditions, increased by 2 degrees to account for uncertainties in the ballasting and wind speed (i.e. a minimum of 2 degrees must be considered)

Note: the effect of the known inclination of the route on the centre of gravity to produce a **virtual centre of gravity** is clarified in the typical example shown in Section 14.2.714.2.4.

14.2.3 **Load case B.** The stability of the virtual centre of gravity location shall be checked to ensure that the minimum tipping angle when measured to the closest tipping line shall be a minimum of 5 degrees when considering the following:

1. the most extreme possible location of the horizontal and vertical centre of gravity,
2. the design wind speed,
3. when transiting on land, any known inclination of the route which cannot be compensated by levelling of the SPMTs, increased by 2 degrees to account for uncertainties in the route profile (i.e. a minimum of 2 degrees must be considered),
4. when transiting on a barge or bridge link, the defined level/motions of the vessel and bridge link 8
   under the design wave height, wind speed and ballast conditions, increased by 2 degrees to account for uncertainties in the ballasting and environmental conditions (i.e. a minimum of 2 degrees must be considered)

5. possible change of heel or trim due to hang-up between the barge and the quay, or dynamic response after release of hang-up, and
6. any free surface liquids within the structure.

Note: the effect of the known inclination of the route on the centre of gravity to produce a **virtual centre of gravity** is clarified in the typical example shown in Section 14.2.7.

14.2.4 Where the hydraulic support system allows for the trailer bed to be levelled horizontally to account for any known inclination, the effect of the known inclination can be reduced to account for this provided this requirement is demonstrated as possible and contained in the procedures. Additionally, it should be documented that the trailer hydraulic suspension system will work within the stroke limits required to allow the adjustment of the level of the trailer bed.

14.2.5 Normally the planned operational stroke should be limited to 70% of the total theoretical stroke length allowing for support heights and/or high/low points along the route although for localised high/low points and localised level compensation adjustment, see Section 14.2.4, this may be increased provided it is documented that the required stroke range is possible.

14.2.6 Very special configurations need to be especially evaluated. In some cases it may be necessary to plan for the possible rearrangement of the trailer after lift-off should the load distribution between the trailer groups not be as expected.

14.2.7 **Virtual Centre of Gravity**. For guidance, the virtual centre of gravity location to be used in the stability calculation is determined as shown in the following example: 8

Assume a structure and trailer assembly with a total weight of 300t with the combined vertical extreme centre of gravity 10m above the ground, an 11t wind load applied at 12m above the ground and a known route inclination of 3 degrees (hence the design ground tilt is 3+2 = 5 degrees).

The virtual horizontal location of the centre of gravity will be the following distance from the original location considered:

Virtual horizontal location of centre of gravity from original horizontal location = {(12x11) + (10x300 x sin5)} / 300 = 1.31m i.e. the virtual centre of gravity is 1.31m closer to the tipping line than the original extreme centre of gravity location considered. Note, the contribution to this shift of 1.31m consists of 0.44m from the wind effect, 0.52m from the known inclination and 0.35m from the allowance of 2 degrees for the uncertainties in the route inclination.

14.2.8 For both Load Case A and Load Case B in sections 14.2.2 and 14.2.3 respectively, it must also be demonstrated that the structure itself is stable on the trailer bed. Where the structure reaction determined from Load Case A or B gives uplift or a value of less than 25% than the static condition, a means of securing the structure to resist the uplift shall be provided and calculations presented to show that the uplift restraint system is suitable.

14.2.9 Special attention shall be given to load-out operations where the CoG of the structure is very close to the centre of a group or grouping of trailers or SPMTs and the CoG has a low elevation. For movements of the structure where slopes are expected and these cannot be compensated by stroking of the SPMTs, the stability of the group or grouping of trailers or SPMTs is to be checked accounting for the slope and the horizontal load from the structure on to the trailers or SPMTs.

14.2.10 A contingency plan shall be presented to cover potential hydraulic leakage or power pack failure.

14.2.11 Load-outs with high slender structures on narrow support bases, or offset from the barge centreline, shall be subject to special attention in terms of the effects of uncertainties in ballasting and de-ballasting.

14.2.12 Where trailers or SPMTs are required to make turns during the load-out operation:

- It must be demonstrated by the load-out contractor that the steering coordinates used in the trailers or SPMTs set up are correct with the details of the set up coordinates contained in the procedures. 8
- The cornering speed shall be kept to a minimum to avoid the potential for loads due to lateral accelerations affecting the stability of the structure or SPMTs. Otherwise, a limiting turn speed shall be specified and the stability assessed accounting for the associated loads.

14.3 VERTICAL ALIGNMENT

14.3.1 Vertical alignment of barge, link beam and quay, including the effects of any change of slope and any movement of the barge due to wave or swell action, should generally be within approximately one third of the maximum travel of the axles relative to the trailer spine.

14.4 SKIDSHOES

14.4.1 As appropriate, the requirements for trailers and SPMTs shall also apply to hydraulically operated skidshoes. The stability of hydraulic skidshoes transverse to their line of action shall be demonstrated to be adequate. Attention should be paid to the effects listed in Section 14.2.

15 PROPULSION SYSTEM DESIGN, REDUNDANCY AND BACK-UP

15.1 The propulsion system, including back-up and contingency systems shall be designed according to the Class of load-out as defined in Table 5-1, and as shown in Table 15-1. Requirements for skidded load-outs include propulsion by wire and winch, hydraulic jacks or stand jacks. Requirements for non-propelled trailer load-outs include propulsion by wire and winch or tractors.

15.2 "System redundancy" means that adequate back-up systems shall be provided such that the load-out can either still proceed in the event of failure of any one mechanical component, hydraulic system, control system, prime mover/power source, or it can be demonstrated that a repair is possible within the periods shown in the in Table 5-1.

15.3 Where Table 15-1 states that a requirement is "recommended" and it is not planned to provide that requirement, a risk assessment shall be carried out, and the risks shown to be acceptable to the approving office. "Recommended" shall be taken to read "required" if a foreseeable failure could extend the operation outside the planned window.

15.4 Where a requirement is assumed to be "built-in", including reversibility of motion, it shall be demonstrated that this is indeed the case.

15.5 Where the propulsion method induces a reaction between the barge and the quay, then the possible effects of this reaction shall be considered, including "hang-up" and sudden release. (See also Section 8.2.1). Mooring line tensions may also contribute to the reaction.

15.6 Where a pull-back system is required, and is achieved by de-rigging and re-rigging the pull on system, then the time taken to achieve this shall be defined, taking into account the Class of load-out.

15.7 The nominal 100% push/pull requirement used in Table 15-1 represents the load needed to overcome the friction resistance for the static / dynamic conditions and any additional loads. The friction resistance shall be calculated by multiplying combined weight by the appropriate friction value in accordance with Sections 15.9 and 15.10. The combined weight is the maximum expected structure weight plus the weight of the load-out equipment to be moved with the structure (e.g. skid shoes, grillage, power units, trailers, jacks etc.). The effect of possible CoG variations should be considered, see Section 8.4 of 0001/ND, Ref. [1], for further information. Where applicable, additional loads (e.g. inertial loads, environmental loads, slope etc.) should be added to the friction component to make up the nominal 100% requirement.

Table 15-1 Propulsion System Design

Class	Intact System Capacity	System Redundancy Requirement after breakdown of any one component	Pull-back System
1a and 1b	160%	130%, or repair possible within 30 minutes	Required
2a	140%	120%, or repair possible within 2 hours	Recommended
2b	120%	Repair possible	Not required
3a	120%	100%, or repair possible within 6 hours	Recommended
3b	100%	Repair possible	Not required
4a and 4b	100%	Repair possible	Not required
5a and 5b	100%	Repair possible	Not required

8

Note:

1 Where "recommended" is stated, and it is not planned to provide that requirement, a risk assessment shall be carried out, and the risks shown to be acceptable to the approving office. "Recommended" shall be taken to read "required" if a foreseeable failure could extend the operation outside the planned window.

2 Where a repair is given as a redundancy option, the feasibility of the repair is to be demonstrated through documentary evidence.

15.8 The system capacity and pull back requirements for self-propelled trailers (SPMTs) or non-propelled trailers are similar to those of Section 15.7 with the friction loads based on the maximum rolling values given in Table 15-2.

15.9 The coefficients of friction used for design of propulsion systems shall not be less than the “maximum” values shown in the following table, unless justification can be provided for a lower value. The “typical” values shown are for information only, and should be justified if used. All sliding interfaces should be suitably lubricated unless this is not required by the supplier of any specialised equipment used for the load-out skidshoe, skidrail etc.

Table 15-2 Typical Friction Coefficients

Level surfaces	Static		Moving	
	Typical	Maximum	Typical	Maximum
Sliding				
Steel / steel	0.15	0.30	0.12	0.20
Steel / Teflon	0.12	0.25	0.05	0.10
Stainless steel / Teflon	0.10	0.20	0.05	0.07
Teflon / unwaxed wood	0.25	0.40	0.08	0.10
Teflon / waxed wood	0.14	0.25	0.05	0.08
Steel /waxed wood	0.20	0.28	0.1	0.15
Rolling				8
Steel wheels /steel	0.01	0.02	0.01	0.02
Rubber tyres / steel or asphalt	-	0.03	-	0.03
Rubber tyres /compacted gravel	0.03	0.05	0.03	0.05

15.10 Where a structure is supported for an extended period on a skidway system, the effect of the degradation of the lubricant between the support and the skidway system should be investigated. This is particularly important where unwaxed wood is used as part of the interface as the lubricant may disperse into the wood giving higher breakout requirements than anticipated. The effects of skidway deformation shall also be considered.

15.11 For operations where the load-out is carried out onto a floating barge (classes 1a, 1b,, 2a, 2b, 3a and 3c) a braking system shall be supplied. The capacity of the braking system shall be suitable to resist any slope (along the ground or from barge trim), the inertia of the structure allowing for possible extreme low friction values.

15.12 For operations where the load-out is carried out onto a grounded barge (classes 4a, 4b, 5a and 5b) a braking system shall be supplied. The capacity of the braking system shall be suitable to resist any ground slope and the inertia of the structure allowing for possible extreme low friction values.

15.13 The nominal computed load on winching systems shall not exceed the certified working load limit (WLL), after taking into account the requirements of Sections 15.7 and 15.9 and after allowance for splices, bending, sheave losses, wear and corrosion. If no certified WLL is available, the nominal computed load shall not exceed one third of the breaking load of any part of the system.

15.14 The winching system should normally be capable of moving the structure from fully on the shore to fully on the barge without re-rigging. If re-rigging cannot be avoided, then this should be included in the operational procedures, and adequate resources should be available.

15.15 For skidded load-outs the structure may be moved closer to the quay edge prior to the commencement 8
of load-out.

15.16 The movement of the structure should not be stopped in areas with the potential for settlement due to e.g. consolidation or adverse weather.

16 LIFTED LOAD-OUTS

16.1 Where the structure is lifted onto the barge by shore-based or floating crane, the requirements of 0027/ND, Ref. [2], shall apply, as appropriate.

16.2 Loads imposed by shore-based mobile cranes on the quay shall be shown to be within allowable values, either by calculation or historical data.

16.3 Floating cranes shall be moored as required by Section 11. Thruster assistance may be used if available to augment the mooring arrangement following successful DP tests carried out immediately
prior to load-out. If DP vessels are to be used then the requirements of Section 13 of 0001/ND, Ref. [1], 8
will apply.

16.4 Where the offshore lifting padeyes are used for load-out, then a programme for inspection of the lift points after load-out shall be presented. As a minimum, inspection of the padeyes and their connection into the structure shall be carried out by a qualified NDT inspector in accordance with the original fabrication drawings. Access for this (including the possible de-rigging of the lift point) shall be provided as required. At the discretion of the attending surveyor, additional NDT inspections may be required.

16.5 If the offshore lift rigging is used for load-out then the rigging shall be inspected by a competent person prior to departure of the structure.

17 TRANSVERSE LOAD-OUTS

17.1 Load-outs where the Structure is moved transversely onto the barge require special consideration and care, for various, but not limited to, the following reasons:

- In nearly all cases the ballast plan must take account of additional parameters. Structure weight transfer, transverse heel, longitudinal trim and tidal level must all be considered.
- Friction between the side of the barge and the quay may be more critical than for an end-on load-out, as there may be a smaller righting moment available in heel than in trim to overcome this force. Snagging or hang-up can lead to the ballast operator getting out of synchronisation with the structure travel. Release of the snagging load has led to instability and failures.
- Stability may be more critical than for an end-on load-out and changes of heel may be significant. The moment to change the barge heel 1 degree should be computed and understood for all stages of load-out.

17.2 A risk assessment should be made of the effects of potential errors in ballasting, and of friction between the barge and the quay.

17.3 Calculations should be carried out for the full range of probable GM values, structure weight and centre of gravity predicted during load-out.

17.4 Where a winch or strand jack system is used to pull the structure onto the barge, the effects of the pulling force on the friction on the fenders should be considered.

17.5 For sliding surfaces between the barge and the quay, particular attention should be paid to lubrication and use of low friction or rolling fenders.

17.6 Ballasting calculations for transverse load-outs shall be based on the weighed weight and CoG and include load combinations addressing weight and CoG contingencies. See also Section 13 and in particular Section 13.3.

18 BARGE REINSTATEMENT AND SEAFASTENINGS

18.1 Seafastening work shall be started as soon as possible after positioning the structure on the barge.

18.2 No movement of the barge shall take place until sufficient seafastening is completed to withstand the greatest of:

1. an inclination equivalent to a horizontal force of 0.1 x structure weight, or
2. the inclination caused by damage to any one compartment of the barge, or
3. the direct wind loading, and inclination due to the design wind.

Inclination loadings shall be applied at the structure centre of gravity; direct wind load shall be applied at the structure centre of area.

It should also be justified that any impact on the barge (e.g. from mooring operations to the quayside) will not cause any loads on the structure which would jeopardise the integrity of the vertical supports of the object. 8

18.3 In specific circumstances where very limited barge movements may be required, e.g. turning from end-on to alongside the quay before it is practical to install seafastenings fully in accordance with Section 18.2, then friction may be allowed to contribute to the seafastenings, provided that it forms part of a design load case and that it can be generated before the seafastening becomes overstressed. Design and condition of the actual supporting structure, and potential sliding surfaces, at the time of movement, must be taken into account. The possibility of contaminants such as grease, water or sand, which may reduce the friction between the sliding surfaces, should be assessed. 8

18.4 The greatest of the loadings shown in Section 18.2 may be considered to be an extreme loading, and the seafastening strength assessed as a LS2 limit state (environmental load dominated) as described in Section 6.1.10.

18.5 Approval of barge movements in any case shall be subject to the specific approval of the attending surveyor, after consideration of the procedures for moving the barge, the state of completion of the seafastenings and the weather and tidal conditions for the movement.

18.6 Any manhole covers which have been opened for ballast water transfer or other reasons shall be closed watertight as soon as practical after use.

18.7 Any holes cut for ballasting purposes shall be closed as soon as practical and the barge certification and class reinstated before sailaway.

18.8 Final seafastening connections should be made with the barge ballast condition as close as practical to the transport condition.

19 TUGS

19.1 Approved tugs shall be available or in attendance as required, for barge movements, removal of the barge from the load-out berth in the event of deteriorating weather, or tug back-up to the moorings.

19.2 Towing operations following load-out should generally be in accordance with GL Noble Denton document 0030/ND – "Guidelines for Marine Transportations" Ref. [3].

19.3 If tugs are used as part of the load-out, inspections shall be carried out as part of the approval, i.e. for communications and adequacy. Tug inspections shall be carried out at least 12 hours prior to the start of operations.

20 PROJECT SAFETY AND CONTROL

20.1 SAFETY DURING LOAD-OUT

20.1.1 See Section 5 of 0001/ND, Ref. [1] for information on Health, Safety and Environment.

20.1.2 During the load-out there will be a number of on-going construction activities and hazards present for operations that will be carried out in a relatively short period of time. The Surveyor, and all others involved in load-out operations, should be aware of these hazards and participate in the fabrication yard safety culture that prevails. The hazards include, but are not limited to, those listed below:

- Wires under tension
- Trip hazards, grease on decks and hydraulic oil leaks
- Openings in the barge deck
- High pressure hoses/equipment
- Temporary access bridges /scaffolding /wire hand railing
- Hot works
- Overside working
- Other shipping operations in the vicinity.

20.2 MANAGEMENT AND ORGANISATION

20.2.1 See Section 6 of 0001/ND, Ref. [1] for information on Organisation, Planning and Documentation.

20.2.2 The documentation to be submitted shall include the load-out manuals including procedures and the supporting technical calculations addressing the requirements of this Guideline.

20.2.3 Shift changes shall be avoided at critical stages of load-out.

20.2.4 A readiness meeting should be held shortly before the start of load-out, attended by all involved parties.

20.2.5 A weather forecast from an approved source, predicting that conditions will be within the prescribed limits, shall be received not less than 48 hours prior to the start of the operation, and at 12 hourly intervals thereafter, or more frequently if appropriate, until the barge is moored in accordance with Section 11 and the seafastening is completed in accordance with Section 18.2.

REFERENCES

[1] GL Noble Denton 0001/ND – General Guidelines for Marine Projects.

[2] GL Noble Denton 0027/ND – Guidelines for Marine Lifting & Lowering Operations.

[3] GL Noble Denton 0030/ND – Guidelines for Marine Transportations.

[4] GL Noble Denton 0032/ND – Guidelines for Moorings.

[5] GL Noble Denton 0035/ND – Guidelines for Offshore Wind Farm Infrastructure Installation

[6] DNVGL-SE-0080 – Noble Denton marine services – Marine Warranty Survey

All GL Noble Denton Guidelines can be downloaded from https://www.dnvgl.com/rules-standards/noble-denton-maa-rules-and-guidelines.html

APPENDIX A - CHECK LIST OF INFORMATION REQUIRED FOR APPROVAL

A.1 MANUALS AND PROCEDURES

A.1.1 The documentation described in Section 20.2.2.

A.2 STRUCTURE

A.2.1 Structural analysis report, including:

- Structural drawings including any additional load-out steelwork
- Description of analyses programs used
- Structural model
- Description of support conditions
- Loadcases including derivation of weights and contingencies
- Unity checks greater than 0.8 for members and joints
- Justification of over-stressed members
- Detailed checks on structure support points, padeyes, winch connection points
- Proposals for reinforcements if required.

A.2.2 Weight report for structure (including results of weighing operation and load cell calibration certificates).

A.3 SITE

A.3.1 Site plan, showing load-out quay, position of structure, route to quay edge if applicable, position of all mooring bollards and winches and any reinforced areas with allowable bearing capacities.

A.3.2 Section through quay wall.

A.3.3 Drawing showing heights above datum of quay approaches, structure support points, barge, link beams, pad (if applicable) and water levels. The differential between civil and bathymetric datums shall be clearly shown.

A.3.4 Statement of maximum allowable loadings on quay, quay approaches, wall, grounding pads and foundations.

A.3.5 Specification and capacity of all mooring bollards and other attachment points proposed.

A.3.6 Bathymetric survey report of area adjacent to the quay and passage to deep water, related to same datum as item A.3.3.

A.3.7 Bathymetric survey of pad, for grounded load-outs, related to the same datum as item A.3.3.

A.3.8 Structural drawings of skidways and link beams, with statement of structural capacity, construction (material and NDT reports) and supporting calculations.

A.3.9 Method of fendering between barge and quay, showing any sliding or rolling surfaces and their lubrication.

A.4 BARGE

A.4.1 General arrangement and compartmentation drawings.

A.4.2 Hydrostatic tables and tank tables.

A.4.3 Details of class.

A.4.4 Static stability at all stages of load-out.

A.4.5 Allowable deck loadings and skidway loadings if applicable.

A.4.6 Specification and capacity of all mooring bollards.

A.4.7 Details of any additional steelwork such as grillages or winch attachments.

A.4.8 Details of barge pumping system.

A.5 TRAILERS

A.5.1 Trailer specification and configuration.

A.5.2 Details of any additional supporting steelwork, including link span bridges and attachments.

A.5.3 Allowable and actual axle loadings.

A.5.4 Allowable and actual spine bending moments and shear forces.

A.5.5 Schematic of hydraulic interconnections.

A.5.6 Statement of hydraulic stability of trailer or SPMT system, with supporting calculations.

A.5.7 For SPMTs, details of propulsion axles and justification of propulsion capacity.

A.5.8 Details of set up coordinates for the trailer or SPMT grouping 8

A.5.9 Specifications of tractors if used.

A.6 PUMPS

A.6.1 Specification and layout of all pumps, including back-up pumps.

A.6.2 Pipe schematic, and details of manifolds and valves where applicable.

A.6.3 Pump performance curves.

A.7 JACKING AND/OR WINCHING

A.7.1 Jack/winch specification.

A.7.2 Layout of pull-on system.

A.7.3 Layout of pull-back and braking systems.

A.7.4 Details of power sources and back-up equipment.

A.7.5 Calculations showing friction coefficient, allowances for bending and sheaves, loads on attachment points and safety factors.

A.7.6 Reactions induced between barge and quay.

A.8 BALLAST CALCULATIONS

A.8.1 Planned date, time and duration of load-out, with alternative dates, tidal limitations and windows.

A.8.2 Ballast calculations for each stage showing:

- Time
- Tidal level
- Structure position
- Weight on quay, linkbeam and barge
- Ballast distribution
- Barge draft, trim and heel
- Pumps in use, and pump rates required
- Moment to change heel and trim.

A.8.3 Stages to be considered should include as a minimum:

- Start condition with structure entirely on shore
- A suitable number of intermediate steps, e.g. 25%, 50% and 75% of travel, steps of 5 axles, or half jacket node spacing, whichever is appropriate
- 100% of weight on barge
- Any subsequent movements on barge up to the final position.

A.8.4 Any stages requiring movement or reconnection of pumps shall be defined.

A.9 LIFTED LOAD-OUTS

A.8.5 Crane specification, including load-radius curve.

A.8.6 Copy of crane certification.

A.8.7 Slinging arrangement.

A.8.8 Copy of certificates of slings, shackles and other equipment. These certificates shall be issued or endorsed by bodies approved by an IACS member or other recognised certification body accepted by GL Noble Denton.

A.8.9 For mobile cranes, position of crane at pick-up and set-down, travel route if applicable, actual and allowable ground bearing pressures at all locations.

A.8.10 Non-destructive testing report of lifting attachments and connection into structure.

A.8.11 Mooring arrangements and thruster specification for floating cranes.

A.8.12 If the lift points and offshore lift rigging will be re-used offshore, proposals for inspection after load-out.

A.8.13 Rigging calculations.

A.10 MOORINGS

A.10.1 Limiting design and operational weather conditions for load-out.

A.10.2 Mooring arrangements for load-out operation and post-load-out condition.

A.10.3 Mooring design calculations showing environmental loads, line tensions and attachment point loads for limiting weather condition for load-out, and for post-load-out moorings if applicable.

A.10.4 Specification and certificates of all wires, ropes, shackles, fittings and chains. These certificates shall be issued or endorsed by a body approved by an IACS member or other recognised certification body accepted by GL Noble Denton.

A.10.5 Specification for winches, details and design of winch foundation/securing arrangements.

A.10.6 Details of fendering including lubrication arrangements as appropriate.

A.11 TUGS

A.11.1 Details of any supporting tugs including bollard pull and towing equipment.

A.12 MANAGEMENT

A.12.1 Organogram showing management structure and responsibilities.

A.12.2 Location of key personnel.

A.12.3 Details of manning levels, showing adequate coverage for all operations and emergency procedures.

A.12.4 Times of shift changes, if applicable.

A.12.5 Weather forecast arrangements.

A.12.6 Communications.

A.12.7 Adequate lighting for all critical areas.

A.12.8 Operation bar-chart showing time and duration of all critical activities including:

- Mobilisation of equipment
- Testing of pumps and winches
- Testing of pull-on and pull-back systems
- Barge movements
- Initial ballasting
- Structure movements
- Load-out operation
- Trailer removal
- Seafastening

- Re-mooring
- Decision points.

A.12.9 Methods of monitoring barge level and trim, and ballast quantities, including consideration of hang-up between barge and quay.

A.12.10 If a computerised ballast control system is to be used, a description of the system, with back-up arrangements, should be supplied.

A.12.11 Time and place for progress and decision meetings.

A.12.12 Safety procedures.

A.12.13 Management of Change procedure.

A.12.14 HAZOPs, HAZIDs and Risk Assessments.

A.13 CONTINGENCIES

A.13.1 Contingency plans shall be presented for all eventualities, including as appropriate:

- Pump failure
- Mains power supply failure
- Jack-winch failure
- Trailer/skidshoe power pack failure
- Trailer/skidshoe hydraulics failure
- Trailer tyre failure
- Tractor failure
- Failure of any computerised control or monitoring system
- Mooring system failure
- Structural failure
- Deteriorating weather
- Quay failure
- Crane failure
- Tugger line failure.