GL Noble Denton

TECHNICAL POLICY BOARD

GUIDELINES FOR FLOAT-OVER INSTALLATIONS

0031/ND

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Date	Revision	Prepared by	Authorised by

PREFACE

This document has been drawn with care to address what are likely to be the main concerns based on the experience of the GL Noble Denton organisation. This should not, however, be taken to mean that this document deals comprehensively with all of the concerns which will need to be addressed or even, where a particular matter is addressed, that this document sets out the definitive view of the organisation for all situations. In using this document, it should be treated as giving guidelines for sound and prudent practice on which our advice should be based, but guidelines should be reviewed in each particular case by the responsible person 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 advice given is sound and comprehensive.

Whilst great care and reasonable precaution has been taken in the preparation of this document to ensure that the content is correct and error free, no responsibility or liability can be accepted by GL Noble Denton for any damage or loss incurred resulting from the use of the information contained herein.

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1 SUMMARY

1.1 This document has been developed to provide guidelines for the float-over installation of structures onto:

- Offshore pre-installed structures, e.g. jackets and concrete units, or
- Offshore or inshore floating structures, e.g. TLPs, concrete units and semi-submersibles.

1.2 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.

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

1.4 The document includes the requirements for consideration, intended to represent good practice, for the following phases :

- Engineering
- Barge selection
- Positioning and manoeuvring
- Set down
- Barge removal
- Operational considerations.

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

2 INTRODUCTION

2.1 GENERAL

2.1.1 This guideline refers to the inshore or offshore float-over of structures onto both fixed and floating structures. It contains general recommendations and checklists of information required to allow approval of such operations by GL Noble Denton.

2.1.2 Due to the range of float-over methods, this document does not cover all aspects of every 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 and good engineering and operational practices.

2.2 START AND COMPLETION OF OPERATIONS

2.2.1 Transportation is generally defined as being completed when:

- The towage or transportation has arrived at the installation location and authorisation to start installation operation has been received from relevant bodies, or
- Installation has started at the installation site (typically within the 500m exclusion zone).

2.2.2 Installation is generally defined as starting when:

- all preparations for float-over have been completed, and
- the prevailing weather and weather forecast are acceptable, and
- the Certificate of Approval has been issued, and
- cutting of seafastenings has started.

In specific cases, the start of the installation may be defined as the point of handover or transfer of control of the transportation barge to the installation spread.

2.2.3 Installation is generally defined as being completed when the structure is lowered on the host structure according to agreed installation procedures and the transportation barge has left the installation site (e.g. the 500m exclusion zone).

2.3 OTHER GL NOBLE DENTON GUIDELINE DOCUMENTS

2.3.1 This document refers to, and should be read in conjunction with other GL Noble Denton Guideline documents, particularly:

- 0013/ND - Guidelines for Loadouts, Ref. [1]
- 0015/ND - Concrete Offshore Gravity Structures – Guidelines for Approval of Construction, Towage and Installation, Ref. [2]
- 0027/ND - Guidelines for Marine Lifting Operations, Ref. [3]
- 0030/ND - Guidelines for Marine Transportations, Ref. [4]
- 0032/ND – Guidelines for Moorings, Ref. [5]

2.3.2 Care should be taken when referring to any GL Noble Denton guideline document that the latest revision is being referenced.

2.4 CODES AND LEGISLATION

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

2.4.2 Care should be taken that the design and planning of an installation operation comply with relevant standards and national and international legislation, e.g. established offshore design codes (API, NORSOK, ISO, DNV, etc.) suitably augmented as necessary for local conditions by project specific design briefs.

2.5 DOWNLOADS

2.5.1 All GL Noble Denton Guidelines can be downloaded from www.gl-nobledenton.com.

3 DEFINITIONS AND ABBREVIATIONS

3.1 Referenced definitions are underlined.

Term or Acronym	Definition
50/50 weight estimate	The values representing the median value in the probability distribution of weight.
AHV	Anchor Handling Vessel
Approval	The act, by the designated GL Noble Denton representative, of issuing a Certificate of Approval
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 Vessel or Ship 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
DP	Dynamic Positioning
Float-over	The operation of installation of a structure onto a host structure by manoeuvring and ballasting the transport barge to effect load transfer
GBS	Gravity Base Structure
GL Noble Denton	Any company within the GL Noble Denton Group including any associated company which carries out the scope of work and issues a Certificate of Approval, or provides advice, recommendations or designs as a consultancy service
HAT	Highest Astronomical Tide
HAZID	Hazard Identification review
HAZOP	Hazard Operability review
Heave	Barge motion in a vertical direction
Host Structure	The host structure (e.g. jacket, GBS ,TLP) onto which the structure will be floated and supported
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
LAT	Lowest Astronomical Tide
LMU / Leg Mating Unit	Unit that is designed and installed on the host structure legs to receive the structure. It is designed to absorb vertical and horizontal installation motions and forces. LMU's can be also installed on the structure.
LRFD	Load and Resistance Factor Design
LSF / Loadout Support Frame	Frame that spans between the underside of the structure and the barge / vessel load spreading grillage
MRU	Motion Reference Unit
MSL	Mean Sea Level
NTE Weight	A Not To Exceed weight, sometimes used in projects to define the maximum allowable installation weight of a structure
Operational reference period	The planned duration of an operation including a contingency period.

Term or Acronym	Definition
Sand Jacks	A compartment filled with sand that is incorporated into the LMU to allow the final controlled lowering of the structure onto the host structure
Seafastenings	The means of restraining movement of the loaded structure or cargo on or within the barge or ship
Ship	See barge
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
SLS / Serviceability Limit State	A design condition defined as a normal Serviceability Limit State / normal operating case
Structure	The object to be floated onto a host structure
Surge	Barge motion in the longitudinal direction
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 l 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, naviagtional or Class survey.
Sway	Barge motion in the transverse direction
Tether	A tether is a mooring line used for pulling and mooring the installation barge into the required position
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.
TLP	Tension Leg Platform
TMPS / Tug Management Positioning System	A system installed on the AHV and the Installation barge to allow the accurate placing of the tug and anchors.
ULS / Ultimate Limit State	A design condition defined as Ultimate Limit State / survival storm case
Vessel	A marine craft designed for the purpose of transportsation by sea. See barge
Weather restricted operation	A marine operation which can be completed within the limits of an operational reference period with a favourable weather forecast (generally less than 72 hours), taking contingencies into account. The design environmental condition need not reflect the statistical extremes for the area and season. A suitable factor should be applied between the design weather conditions and the operational weather limits.
Weather un-restricted operation	An operation with an operational reference period greater than the reliable limits of a favourable weather forecast (generally less than 72 hours). The design weather conditions must reflect the statistical extremes for the area and season.

4 THE APPROVAL PROCESS

4.1 GENERAL

4.1.1 GL Noble Denton may act as a Warranty Surveyor, giving Approval to a particular operation, or as a Consultant, providing advice, recommendations, calculations and/or designs as part of the Scope of Work. These functions are not necessarily mutually exclusive.

4.2 GL NOBLE DENTON APPROVAL

4.2.1 GL Noble Denton means any company within the GL Noble Denton Group including any associated company which executes the scope of work and issues a Certificate of Approval.

4.2.2 GL Noble Denton approval may be sought where an operation is the subject of an Insurance Warranty, or where an independent third party review is required.

4.2.3 An Insurance Warranty is a clause in the insurance policy for a particular venture, requiring the approval of a marine operation by a specified independent survey house. The requirement is normally satisfied by the issue of a Certificate of Approval. Responsibility for interpreting the terms of the Warranty so that an appropriate Scope of Work can be defined rests with the Assured.

4.3 CERTIFICATE OF APPROVAL

4.3.1 The deliverable of the approval process will generally be a Certificate of Approval.

4.3.2 The Certificate of Approval is the formal document issued by GL Noble Denton when, 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.

4.3.3 The Certificate confirming adequate preparation for an operation will normally be issued immediately prior to the start of the operation, by the attending surveyor.

4.4 SCOPE OF WORK LEADING TO AN APPROVAL

4.4.1 In order to issue a Certificate of Approval for a float-over operation, GL Noble Denton will typically consider the topics and information listed in Appendix A.

4.4.2 A Certificate of Approval for a float-over operation covers the marine operations involved in the float-over procedure. Float-over is normally deemed to start at the time when all preparations for float-over are complete (moorings installed, host structure preparations complete, structure prepared) and a suitable weather forecast is received showing that environmental conditions are expected to be less than the design allowables for the maximum duration of the operation, including contingencies.

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

a. Reviews of specifications, 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.

4.4.4 Surveys required typically include preliminary surveys of the barge, structure and site; attendance at weighing and loadout operations; surveys of readiness to start float-over and witnessing of float-over operations.

4.5 LIMITATION OF APPROVAL

4.5.1 A Certificate of Approval is issued for a particular float-over operation only.

4.5.2 Fatigue damage is excluded from any GL Noble Denton approval, unless specific instructions are received from the client to include it in the scope of work.

4.5.3 A Certificate of Approval is issued based on external conditions observed by the attending surveyor of hull(s), machinery and equipment, without removal, exposure or testing of parts.

4.5.4 Any alterations to the surveyed items or agreed procedures after issue of the Certificate of Approval may render the Certificate invalid unless the changes are approved by GL Noble Denton in writing, after review and approval of supporting documentation as required by GL Noble Denton.

4.6 SAFETY DURING FLOAT-OVER

4.6.1 During the float-over there will be a number of simultaneous hazardous activities carried out in a relatively short period of time. The Surveyor, and all others involved in float-over operations, should be aware of these hazards and participate in the operational safety briefings. The hazards include:

- Wires / ropes under tension
- Working at height
- Trip hazards, grease on deck and hydraulic oil leaks
- Openings in the barge deck
- High pressure hoses / equipment
- Temporary access bridges / scaffolding / wire hand railing
- Hot works
- Overside working
- Green water on the deck of the barge.

5 LOADOUT AND TRANSPORTATION

5.1.1 Structure loadout shall be generally carried out in accordance with GL Noble Denton Loadout guidelines 0013/ND Ref [1].

5.1.2 Structure transportation shall be generally carried out in accordance with GL Noble Denton Marine Transportation guidelines 0030/ND Ref [4].

5.1.3 In-field mooring of the transportation barge shall generally be carried out in accordance with Section 9.6 to 9.10 of these guidelines and GL Noble Denton Moorings Guidelines 0032/ND, Ref [5].

6 DESIGN ENVIRONMENTAL CONDITIONS

6.1 PRINCIPLES

6.1.1 For each phase of a marine operation / float-over installation, the limiting design criteria should be defined, consisting of the design wind speed, wave height and period range and current speed. Directional criteria can be specified. Co-linearity should be assumed unless location data indicates otherwise.

6.1.2 Final selection of the limiting design environmental conditions should be based on the following:

- Weather windows analysis
- Motions / clearances during the installation
- Structural strength of the barge, structures and the installation components
- Mooring capability assessment (if applicable)
- DP capability assessment (if applicable)
- Cost benefit analysis considering the items listed above.

6.2 OPERATIONAL REFERENCE PERIOD

6.2.1 Planning and design of the float-over installation shall be based on an operational reference period equal to the planned duration of the operation plus a contingency period.

6.2.2 The planned duration for the installation shall include, typically:

- The time anticipated, after the decision to proceed, preparing for installation or waiting for the correct tidal conditions
- The time anticipated for the installation itself.

6.2.3 The contingency period shall include allowances for:

- Slower than predicted installation operation, and
- Possible mechanical breakdown of key items of equipment.

6.3 WEATHER-RESTRICTED OPERATIONS

6.3.1 An installation with an operational reference period generally less than 72 hours may be classed as a weather-restricted operation and this will typically be the case for a float-over. The design environmental conditions for such an operation may be set independent of extreme statistical data, provided that;

- The statistics indicate an adequate frequency and duration of the required weather windows
- Dependable weather forecasts are available
- The start of the installation is governed by an acceptable weather forecast, covering the operational reference period
- Adequate marine procedures are in place.

6.3.2 An installation with an operational reference period greater than 72 hours may exceptionally be classed as a weather-restricted operation, provided that;

- An acceptable weather forecast service is contracted and is available for advice at any time
- Weather forecasts are received at appropriate intervals
- Management resources of interested parties are always available with the right authority level to monitor any operation decisions
- A risk assessment has been carried out and the results accepted by GL Noble Denton
- Adequate marine procedures and equipment are in place.

6.3.2.1 Unless agreed otherwise with GL Noble Denton, for marine operations with an operational duration of no more than 24 hours the maximum forecast seastate shall not exceed the design seastate multiplied by the applicable factor from Table 6-1 below. For operations with other durations alternative factors apply and should be agreed with GL Noble Denton. The forecast wind and current shall be similarly considered when their effects on the operation or structure are significant.

Table 6-1 Design Seastate Reduction Factor

Weather Forecast Provision	Reduction Factor
No project-specific forecast (in emergencies only)	0.50
One project-specific forecast source	0.65
One project-specific forecast source plus in-field wave monitoring (wave rider buoy)	0.70
One project-specific forecast source plus in-field wave monitoring and offshore meteorologist	0.75

6.4 WEATHER UNRESTRICTED OPERATION

6.4.1 Except as allowed in Section 6.3.2, installations with an operational reference period greater than 72 hours shall be defined as un-restricted operations for the complete operation (this may include connection to and disconnection from a mooring system as applicable). In such cases the design shall be to the 10-year return period monthly extremes, or any lesser conditions that cause more onerous responses.

6.5 "ADJUSTED" DESIGN EXTREMES, UNRESTRICTED OPERATIONS

6.5.1 Normally the load transfer will be carried out during a single tide cycle but consideration needs to be given to the full operation duration. The risk of encountering extreme conditions during a particular float-over installation is dependent on the length of time that it is exposed. If the length of the time is reduced, then the probability of encountering extreme conditions is similarly reduced.

6.5.2 The procedure given in Section 6.5 of 0030/ND, Ref. [4] can be used to determine the 10% risk level extremes taking the exposure duration as equal to the operational reference period. The design extremes shall not be less than the 1-year monthly extremes. If the 10 year extremes are due to a tropical cyclone it may not be appropriate to design to adjusted extremes.

6.6 OPERATIONAL FEASIBILITY

6.6.1 It is recommended that a weather windows analysis be undertaken to demonstrate that the operational design environmental conditions will have a good probability of occurrence within the proposed installation period. The weather window analysis results for a selected installation period should clarify the following:

- An average duration of the weather windows
- The number of windows in a given season.

7 WEIGHT CONTROL

7.1.1 A NTE weight shall be defined for the structure and shall be used in the installation analysis and calculations.

7.1.2 Weight control shall be performed by means of a well defined, documented system, in accordance with current good practice, such as International Standard ISO 19901-5 – Petroleum and natural gas industries – specific requirements for offshore structures – Part 5: Weight control during engineering and construction Ref [6].

7.1.3 Ref [6] states (inter alia) that:

- "Class A (weight control) will apply if the project is weight- or CoG-sensitive for lifting and marine operations or during operation (with the addition of temporaries), or has many contractors with which to interface. Projects may also require this high definition if risk gives cause for concern".
- "Class B (weight control) shall apply to projects where the focus on weight and CoG is less critical for lifting and marine operations than for projects where Class A is applicable".
- "Class C (weight control) shall apply to projects where the requirements for weight and CoG data are not critical".

7.1.4 Unless it can be shown that a particular structure and specific installation operation is not weight or CoG sensitive, then Class A weight control definition will be needed, as shown in Ref [6], Section 4.2. If the 50/50 weight estimate as defined in Ref [6] is derived, then a reserve of not less than 5% shall be applied. The extremes of the CoG envelope shall be used.

7.1.5 A weight contingency factor of not less than 1.03 shall generally be applied to the final weighed weight. This may be reduced if a Certificate is produced from a Competent Body stating, for the specific case in question, that the weighing accuracy is better than 3%.

7.1.6 Prior to any structure being weighed, a predicted weight and CoG report shall be issued, so that the weighed weight and CoG can immediately be compared with the predicted results.

7.1.7 If any changes take place after weighing or final weight calculation the effect on the float-over procedures of any weight changes shall be assessed, and the procedures modified if necessary.

8 CONSIDERATIONS INFLUENCING BARGE SELECTION CRITERIA FOR LOADOUT AND TRANSPORTATION AND THE FLOAT-OVER

8.1.1 The selected barge must satisfy certain criteria to ensure suitability for all phases of the operation, including load-out, transportation and the float-over operation.

8.1.2 The barge selection process involves several considerations with regard to geometry, other than the factors relating to the float-over operation. Relative heights of grillage and LSF have to be optimised so that grillage height suits loadout by fixing the barge elevation at the quayside to match the yard skidway height, and the combined grillage plus LSF height suits float-over clearances.

8.1.3 Important parameters are:

- The barge beam and depth must be appropriate for the host structure slot
- Barge depth considering minimum and maximum draught, quayside height and tidal range for loadout
- Grillage minimum height requirement for load spreading considering quayside skidway height. This fixes barge elevation at quayside during loadout
- Combined grillage plus LSF height to achieve required clearances at float-over, also considering effect on barge stability and minimum draught
- Adequate depth and ballast capacity and ballasting rate to achieve minimum and maximum drafts for the float-over considering tidal variations
- Global and local strength to ensure structural adequacy of the barge and attachments for all stages during the float-over
- Adequate stability for the transportation (see 0030/ND Ref. [4]) and to meet all Flag State stability requirements
- Adequate freeboard (to avoid green water) and stability at all stages of the operations
- Adequate motion characteristics at all stages of the operations

9 FLOAT-OVER ENGINEERING

9.1 GENERAL

9.1.1 The following sections describe specific requirements which shall be considered as part of the engineering process.

9.2 BARGE LOAD CONDITIONS

9.2.1 The barge loading condition for each stage of docking, mating, load-transfer and undocking operation shall be determined as follows:

- Docking and Pre-installation case. The minimum float-over clearance will be determined based on vessel draught, design of the mating cones and receptacles, environmental conditions for the installation and possible maximum motion amplitudes at the mating points.
- Mating and load transfer stages from the first contact to 100% transfer. These stages shall be analysed for the barge at intermediate draughts, to allow for ballasting and fall of tide.
- Undocking stages from 100% load transfer to separation. These stages and undocking stages shall be analysed for the barge at a deep draught, to maximize separation clearances on a falling tide and under keel clearance.

9.3 STABILITY DURING INSTALLATION

9.3.1 Barge stability shall be shown to be adequate throughout the installation operation. Particular attention should be paid to:

- Stability checks should be carried out for the full range of probable GM values, module weight and centre of gravity predicted during installation, this must include the effects of deballasting the barge and jacking the module where applicable.
- Any installation with a small metacentric height, where an offset centre of gravity (structure) may induce a heel or trim during the ballasting / weight transfer i.e. when any transverse / longitudinal moment ceases to be restrained by the host structure.
- Cases where a change of wind velocity or wave direction may cause a significant change of heel and trim during the installation.
- During float-over installation it may be necessary to maximise float-over clearance by minimising the barge draught within stability limitations. For this case only intact stability need be considered with a positive GM not less than the Flag State's minimum requirements.

9.4 MOTIONS AND MATING STAGES

9.4.1 Devices to assist or control the safe entry of the installation barge into the host structure slot shall be provided. These devices can be on the installation barge, the host structure, or both. The engineering properties (strength, stiffness, damping, hysteresis, elastomeric creep) of all the components and systems for mating shall have been verified by tests which cover the full range of conditions (e.g. forces, displacements) anticipated for the installation operation.

9.4.2 The motions of the transportation barge and associated docking, mooring line and fender loads shall be analysed in the time domain for docking, load transfer and undocking positions, including non-linear effects of the stiffness of the host structure / deck / barge, mooring configuration, shock absorbers, fendering system, etc.

9.4.3 The motions of the barge and associated docking mooring line and fender loads shall be analysed in the time domain for several docking and undocking positions such as:

- Pre-docking, free floating motions with the barge aligned with the first row of the host structure
- Docking, intermediate stage with the whole barge engaged with the host structure
- Docked, with the barge offset from the pre-mating position, prior to finally tensioning the mating moorings
- Undocking, with the barge in an offset position, after full transfer of the deck weight to the host structure and release of the mating moorings.

9.4.4 Mating stages shall be selected and analysed in the time domain to identify associated loadings to all the interfaces associated in the weight transfer process. As a minimum this shall include barge docking, load transfer and barge removal:

- Pre-mating, with the barge and structure positioned in the host structure, and aligned with but prior to engaging the stabbing cones or positioning system(s) on the LMU's / host structure.
- First contact between the structure and host structure
- Intermediate load transfer, with the structure weight partially transferred from the barge to the host structure, without any separation or lift off at the support points
- Last contact between the structure and the support point on the barge
- Post-load transfer, with the vessel positioned in the host structure after complete separation from the host structure.

9.4.5 A Monte Carlo simulation shall be performed to define maximum values with an acceptable probability of exceedance of 10% or less. The simulation period for each stationary stage shall reflect the actual operational period multiplied by a factor of two to capture a contingency period. The time step to be used shall be selected so as to identify the maximum peak motion

9.4.6 A Leg Mating Unit (LMU) design shall be carried out taking into account the loads, stroke and motion response expected to be applied during load transfer operations. The LMU performance characteristics shall be included in the mating analysis

9.4.7 An assessment shall be made to consider the speed at which the structure and barge can separate. As the barge starts to separate from the structure there will be a tendency for re-contact at the LSF / structure interface due to the barge motions. Mitigations shall be considered to avoid damage to structure and LSF / barge

9.4.8 Where a rapid load transfer is required, a jacking system may be utilised. The jacking system shall be designed to ensure the stability and restraint of the structure as it is raised above its transportation position. Redundancy shall be provided in the jacking system so that there is no single point of failure in the system. Detailed HAZIDs will be required of the jacking system if used

9.4.9 Where float-over operations are conducted in the shelter of a breakwater (e.g. for tanker loading facilities at coastal locations), the adverse effects of the breakwater on the waves and current should be considered when determining the environmental loading on the installation barge.

9.5 CLEARANCES

9.5.1 Exclusion zones should be defined in the early phase of the project in order to minimise and avoid clashes during the installation operation.

9.5.2 The maximum draft of the installation barge during float-over shall not exceed the maximum loadline draft, without a class exemption (but see Section 9.5.3). The minimum barge freeboard at the maximum barge draft shall be 1.0m to maintain its water-plane area. Minimum freeboard used during the operation shall be confirmed with the barge owner. The limiting seastate should be such that green water cannot occur on the deck of the barge.

9.5.3 Class exemption for exceeding the transit loadline draft is not needed for semi-submersible heavy lift barges or vessels.

9.5.4 During approach of the structure the minimum (static) vertical clearance between the structure stabbing cone and host structure receptacles / jacket leg / piles shall be 1.0m.

9.5.5 The maximum vertical / horizontal movement of the stabbing cone should not normally exceed +/-0.5m during entry and weight transfer.

9.5.6 The as-built clearances between the stabbing cones and the host structure receptacles / jacket legs shall be checked after loadout operation and the procedures modified, if necessary.

9.5.7 To allow safe removal of the installation barge the minimum clearance between the keel of the installation barge and any part of the submerged host structure shall be 1.0m after accounting for vessel maximum motions at maximum draft.

9.5.8 The minimum vertical clearance between the LSF and the underside of the structure following completion of load transfer shall be 0.5m after accounting for vessel maximum motionsto allow safe removal of the installation barge.

9.5.9 The as-built levels of the host structure should be verified as they can differ from the nominal values due to seabed tolerances, especially where dredging operations are carried out.

9.5.10 The clearances required for inshore float-overs can be reduced by agreement with GL Noble Denton.

9.6 BARGE MOORING AND POSITIONING OVERVIEW

9.6.1 Mooring and positioning of the barge into the host structure can be by:

- pre-laid mooring lines/anchors
- tugs and pre-laid mooring lines
- a barge with a DP system.

9.7 BARGE MOORING AND STAND-OFF MOORINGS

9.7.1 Stand-off mooring shall be provided except for vessels with suitable DP systems.

9.7.2 When required, the installation barge mooring system shall be designed to resist the environmental loads, allowing the barge to maintain position prior to docking. Line integrity and anchor uplift shall also be verified for operational and extreme environment standby cases.

9.7.3 A mooring analysis shall be carried out for the installation barge at the stand-off location and at the incremental stages that comply with the installation procedural steps. The mooring analyses shall satisfy the requirements of GL Noble Denton Mooring Guidelines, 0032/ND, Ref. [5].

9.7.4 All installation barge mooring lines and tethers shall be capable of being tensioned by the use of winches or capstans.

9.8 CLEARANCES AROUND MOORING LINES AND ANCHORS

9.8.1 Clearances around mooring lines and anchors should comply with GL Noble Denton Mooring Guidelines, 0032/ND, Ref. [5]. Exemptions may need to be made for the final float-over stages when close to the host structure; these shall be subject to risk assessment and the results agreed with GL Noble Denton.

9.8.2 All anchor lines shall be pre-installed and pre-tensioned to maximum operating loads with a safety factor and holding period to be agreed.

9.9 POSITION KEEPING DURING MATING WITH TETHERS

9.9.1 During the mating operation, the barge may be held in position by tethers connected to the host structure reacting against the surge fenders (if fitted). Alternatively tethers may operate in both directions, replacing surge fenders.

9.9.2 The tethers shall be designed to hold the barge in the mating position to ensure that the barge motions do not exceed the capture radius of the LMU's during the mating operation. The characteristics of the tethers shall be accurately modelled in the analysis.

9.9.3 Temporary mooring tethers shall be designed for the maximum expected loads and sized based on a factor of safety of 1.67 against the certified break load.

9.9.4 The barge may be also held in position using the barge's propulsion systems with constant thrust against surge fenders.

9.10 BARGE POSITIONING USING A TUG(S) WITH MOORING LINES

9.10.1 A combination of mooring lines and tug(s) can be used for barge positioning.

9.11 BARGE POSITIONING USING A DP SYSTEM

9.11.1 In the event that the float-over barge is a heavy lift ship with dynamic positioning capability (minimum DP Class 2), then consideration can be given to the use of DP in place of barge moorings, subject to review of station keeping analyses and DP operating procedures. The FMEA analysis for the DP system should be submitted for review by GL Noble Denton.

9.11.2 A DP capability assessment shall be made for the barge and structure taking into consideration the design environmental conditions. The DP capability assessment should consider the barge's DP capability for the worst case failure condition and show that the barge is able to complete the operation with the reduced capability, or to abort if prior to the point of no return.

9.11.3 Results of the DP capability assessment shall be taken into account in the weather windows analysis.

9.11.4 Annual DP trials should be up to date and documented.

9.11.5 Full satisfactory documented DP trials shall be completed before the loadout of the structure. These trials shall demonstrate:

- Operation in the intact and post failure configurations
- A group redundancy test as a minimum
- Positioning in the intact and post worst case failure configurations with the reference systems chosen for the operation.

Any tests that can not be completed prior to load-out shall be completed prior to the commencement of the installation operation (such as proving fan-beam reference systems).

9.11.6 Field arrival trials shall be completed on location in actual conditions before the float-over installation operation.

9.11.7 A backup system for DP should be prepared, in case of a DP system failure during the installation.

9.11.8 The backup system for DP can be winch / mooring lines prepared for the positioning of the barge, or the tug(s) which are used to manoeuvre the barge in place.

9.12 HOST STRUCTURE – STRUCTURAL CONSIDERATIONS

9.12.1 The host structure will be subject to a variety of loading conditions during the docking and mating operations. The host structure shall be documented to have adequate global and local strength to withstand such loading. Accidental loadings shall also be considered.

9.12.2 Horizontal restraint shall be provided between the barge and the host structure to absorb shock loads during mating and to prevent lateral movement of the deck after initial engagement of the two parts.

9.12.3 The effects of un-even load distribution during the mating operation shall be calculated and documented.

9.13 FLOATING HOST STRUCTURE – ADDITIONAL STRUCTURAL CONSIDERATIONS

9.13.1 Hydrostatic loads on the host structure at the deepest draft can be the governing loadcase. It shall be demonstrated that a thorough independent check of the calculations covering this loadcase has been carried out, and that the design and reinforcement details assumed in the calculations concur with the as-built condition.

9.13.2 Any limitations on the maximum allowable duration of deep immersion, in relation to the structural stability of the unit, should be established and the procedures planned accordingly.

9.13.3 The horizontal restraint between deck and floating host structure after mating shall be capable of taking the loads resulting from the inclination due to the design storm for the deck mating window, or an inclination of 5 degrees, whichever is the greater, at any applicable draft. Friction may be taken into consideration, but a safety factor against sliding of at least 3 shall be documented.

9.14 FLOATING HOST STRUCTURE – FREEBOARD, STABILITY AND RESERVE BUOYANCY

9.14.1 The stability and reserve buoyancy for a floating host structure shall be agreed on a case by case basis for intact and damaged conditions. In general it will not be possible to have one compartment damaged stability at mating draft so alternative arrangements must be made to keep the Risk As Low As Reasonably Practicable (ALARP).

9.14.2 Freeboard to the lowest downflooding point on a concrete gravity base host structure shall never be less than 6 metres, and the stability requirements of 0015/ND, Ref [2] shall also apply.

9.14.3 The time at the maximum draft, when reserve buoyancy is at a minimum and structural loadings could be at a maximum, should be as short as possible.

9.14.4 Additional freeboard will be required to allow for the response of the unit, unless pitch, roll and heave can be shown to be negligible under the conditions expected.

9.14.5 The substructure without the deck shall be capable of being deballasted to a freeboard at which the unit has damage stability within 24 hours. An initial deballasting capability of not less than 2 metres per hour is recommended.

9.14.6 It should be possible to deballast the deck off the barge(s) within the planned weather window. If this is not practicable then the substructure / deck / barge combination shall be able to survive the 10 year return period seasonal storm at an intermediate condition.

9.14.7 Provision shall be made for the detection of any likely movements of fresh water (freshets) that could cause significant draft changes. The unit shall always be able to deballast to maintain freeboard.

9.14.8 Before the immersion for deck-mating, a comprehensive commissioning and testing programme shall be agreed, undertaken and documented to prove the integrity of the host structure (and systems).

9.14.9 Risk management techniques, as outlined in Sections 16.1.3 and 16.1.4 shall be applied as appropriate.

10 STRUCTURAL STRENGTH

10.1 CODES

10.1.1 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.

10.1.2 Traditionally AISC has also been considered a reference code. If the AISC 13th edition is used, the allowables shall be compared against member stresses determined using a load factor on both dead and live loads of no less than those detailed in the following Table 10-1.

Table 10-1 Load Factors

Type	WSD option	LRFD Option
SLS:	1.00	1.60
ULS:	0.75	1.20

10.1.3 Any load cases shall be treated as a normal serviceability limit state (SLS) / Normal operating case.

10.1.4 The infrequent load cases, generally limited to survival at stand-off location and line / tether / tow-line break cases, may be treated as an ultimate limit state (ULS) / Survival storm case. This does not apply to:

- Steelwork subject to deterioration and/or limited initial NDT unless the condition of the entire loadpath has been verified, for example the underdeck members of a barge
- Steelwork subject to NDT prior to elapse of the recommended cooling and waiting time as defined by the Welding Procedure Specification (WPS) and NDT procedures. In cases where this cannot be avoided by means of a suitable WPS, it may be necessary to impose a reduction on the design/permissible seastate
- Steelwork supporting sacrificial bumpers and guides
- Structures during a load-out.

10.1.5 The extent of NDT testing shall be submitted for review.

10.2 SEAFASTENINGS

10.2.1 Seafastenings on the installation barge shall be designed to:

- Resist seafastening forces during the voyage to the float-over location (see 0030/ND, Ref. [4])
- Minimise offshore cutting
- Provide restraint after cutting equivalent to 5% of the structure weight acting horizontally
- Permit separation without fouling.

10.2.2 A design case shall be established for any seafastenings that remain after initial seafastening cutting with the installation barge in a stand-off position prior to the barge being manoeuvred into the docking slot.

10.2.3 All cut lines should be clearly marked. If cutting in 2-stages, the two sets of cut lines should preferably be marked in different colours.

10.2.4 Where a jacking system is used to achieve clearances during the initial docking and subsequent operations, the jacking system shall be suitable to provide lateral restraint equivalent to 10% of the structure weight acting horizontally.

10.3 FENDERS AND GUIDES

10.3.1 A fendering system shall be provided between the installation barge and the host structure. The design of the system shall be such that it acts to reduce the motions of the installation barge, provide protection to the host structure and guidance for barge entry.

10.3.2 Barge fender design loading shall be derived from the mating analysis. The design friction coefficient shall account for any facings applied to the host structure fenders.

10.3.3 Surge fenders (if applicable) may be fitted to the barge to control the longitudinal position during the mating operation by making contact with the host structure fenders.

10.3.4 Sway fenders shall be fitted to the barge sides to reduce the clearance between the host structure and the barge during the mating operation and so improve the lateral positioning relative to the structure supports. Barge side-shell strength shall be checked for its capacity to resist the applied fender loads.

10.3.5 To facilitate the docking operation, docking guides (if applicable) shall be provided on either side of the docking end of the installation barge(s).

11 PUMPING AND BALLASTING

11.1 PRINCIPLES

11.1.1 A detailed ballasting procedure shall be developed for each stage of the installation operation. The ballast calculations shall include the quantity of water in each ballast tank for each installation stage. The ballast procedure shall consider float-over clearances, keel clearance, load transfer, tidal range, expected timings and barge freeboard.

11.1.2 Allowances shall be made for the effects of residual ballast water in near-empty tanks and achievable maximum ballast quantities in full tanks.

11.1.3 The ballast sequence should be developed so that, if possible, separate tanks are used for tidal compensation and weight compensation.

11.1.4 A risk assessment of the effects of potential errors in ballasting shall be undertaken, documented and the results accepted by GL Noble Denton.

11.2 HOST STRUCTURE BALLASTING EQUIPMENT

11.2.1 The ballasting equipment used for concrete gravity structures shall be designed, constructed and operated in accordance with 0015/ND Ref [2].

11.2.2 Before the immersion for deck mating, a comprehensive commissioning and testing programme shall be agreed, undertaken and documented to prove the integrity of the ballast systems (and structure).

11.3 TIDAL LIMITATIONS

11.3.1 The installation operation will be classed according to the tidal conditions. Requirements for design, reserves and redundancy of mechanical systems will vary according to the class of installation.

Table 11-1 Installation Class

Installation Class	Tidal limitations
1 (Tidal window)	The tidal range is such that regardless of the pumping capacity provided, it is not possible to maintain the mating interfaces with the same/required level throughout the full tidal cycle, and the float-over must be completed within a defined tidal window.
2 (Constant level >24 hrs)	The tidal range is such that whilst significant pumping capacity is required, it is possible to maintain the mating interfaces with the same/required level during the full tidal cycle, and for at least 24 hours thereafter.
3 (Minimum tidal variation)	Tidal range is negligible or zero, and there are no practical tidal constraints on the float-over operation. Pumping is generally required only to compensate for weight changes as the load transfer proceeds. This class will also apply for mating over a floating host structure.

11.4 PUMPING CAPACITY

11.4.1 Pumping capacity shall be provided as follows, depending on the Class of installation as defined in Table 11-1, and to satisfy each condition as defined below:

- CONDITION A: The nominal maximum pump capacity computed for the installation as planned, to compensate for tidal changes and load transfer, with no contingencies.
- CONDITION B: The computed capacity required, as a contingency, to hold the mating interfaces with the same level, at the maximum rate of rising or falling tide, assuming the load transfer is halted.
- CONDITION C: The computed capacity required, as a contingency, to provide the requirements of either Condition A or Condition B, whichever is the greater, in the event of 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.

Table 11-2 Required Pumping Capacity

Installation Class	Condition	Pump capacity required, as a percentage of computed capacity
1 (Tidal window)	A	150%
	B	150%
	C	120%
2 (Constant level >24hrs)	A	150%
	B	120%
	C	100%
3 (Little or no tide)	A	100%
	B	No requirements
	C	75%

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

11.4.3 If the barge pumping system is used as part of the main or back-up pump capacity, then a barge engineer familiar with the system shall be attendance throughout the operation. The float-over communication system should include the pumproom.

11.4.4 All pumps and systems shall be tested and shown to be operational before transportation to the installation site. At the discretion of the GL Noble Denton surveyor, a verification of pump capacity may be required.

11.4.5 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.

11.4.6 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 the float-over between the stations at which they may be required. Adequate resources shall be available to perform this operation.

11.4.7 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.

11.5 BALLASTING AND GAUGING SYSTEMS

11.5.1 The installation barge shall have an integrated ballast system, and shall be capable of ballasting the barge within one tidal cycle (as applicable). The total ballast pump capacity shall be sufficient to maintain the required pumping rates with failure of any one primary pump or power source. Control of the pumping systems and ballast valves shall be from a centralised ballast control room.

11.5.2 The barge shall have a remote tank gauging system capable of continuously monitoring the level of liquids in all ballast tanks simultaneously. The readout of the tank gauges shall be in the ballast control room. The ballast tanks shall also be fitted with sounding tubes or ullage access to allow manual measuring of the tank levels.

12 MARINE EQUIPMENT

12.1 GENERAL

12.1.1 All the equipment on the installation barge, including ship loose items, shall be properly fastened to the deck for the tow and installation phases.

12.1.2 The equipment installed on the installation barge (e.g. winches, fairleads, towing and mooring lines, etc.) shall comply with the requirements of the Marine Warranty Surveyor and have valid certificates.

12.2 INSTALLATION VESSEL CONTROL SYSTEMS

12.2.1 The installation barge shall have an electrical power plant with an independent 100% back up to supply all electrical power for installation operations. The installation barge shall have sufficient lighting to illuminate the complete barge deck and other operating areas to allow the float-over operation to proceed safely on a 24-hour basis.

12.3 LEG MATING UNITS

12.3.1 Shock absorbers and leg mating units (LMUs) shall be provided at the mating interface between the structure and the host structure. The LMUs will dampen vertical and horizontal motions.

12.3.2 A hydraulic jacking system or a rapid ballast system may be used in combination with a mechanism which allows for rapid transfer of the structure to the host structure and establishment of clearance between the structure and the barge / LSF. The system shall be optimized to reduce both the risks of weather downtime and the potential for impact damage between the structure, barge and host structure.

12.3.3 Once the structure weight is fully transferred to the host structure and the barge is removed, final lowering to achieve steel/steel contact may be required.

13 ASSIST TUGS AND SUPPORT VESSELS

13.1.1 A main tug capable of controlling the barge must be provided. This tug should be an AHV or equivalent.

13.1.2 Additional tugs can be required for the mating operations (anchor handling and barge mating assistance). When required these shall be highly manoeuvrable tractor tugs with a specification to meet the needs of the operations. The tugs shall be classed for offshore work (if appropriate) and crewed for 24 hour operations.

13.1.3 Any AHV used for anchor handling shall be fitted with a Tug Management Positioning System (TMPS) which is sufficiently accurate to allow anchors to be positioned within 5m of target.

13.1.4 An accommodation / work vessel may be required for offshore personnel and to permit host structure preparations prior to, during and after the structure float-over. The vessel specification shall be developed to suit the specific requirements of the project.

13.1.5 A work boat for personnel transfer shall be operated by a competent trained coxswain and have sufficient crew members to assist during personnel transfers.

14 FLOAT-OVER INSTALLATION MONITORING EQUIPMENT

14.1 LEG MARKINGS / LEG ACCESS

14.1.1 The identity of each leg shall be clearly marked with row and line reference.

14.1.2 Draft mark elevations shall be painted on the host structure legs. After host structure installation, a survey shall note corrections to be made to the markings for accurate tide measurement. Level markings shall be floodlit so that they are clearly visible during darkness.

14.1.3 Tide boards can be used in case the painted leg markings in the host structure are not adequate for the installation purposes.

14.1.4 Design elevations shown on the host structure legs shall relate to the lower edge of the mark, shall be clearly visible at a distance of not less than 50m and shall include increments at a maximum of 200mm. Corrections by which these marks may be related to MSL, HAT or LAT shall be known.

14.1.5 Host structure leg access platforms shall be incorporated with safe access from the sea for operation and inspection of LMU's. These platforms can also be used for host structure to deck leg weld out.

14.2 MOTIONS / CLEARANCE MONITORING

14.2.1 The following critical factors shall be monitored using an MRU (Motion Reference Unit) for the float-over installation:

- The six degrees of freedom motions of the barge in a free-floating mode. This is to ensure that the motions can be compared with those predicted by the motion analysis. These are usually presented as motions and accelerations at the system centre of gravity and should be used to check that the loads and clearances remain at acceptable levels.
- The vertical clearance between the leg mating units (LMUs) on the structure, and the docking cones on the underside of the host structure during the initial entry of the barge into the host structure.

14.2.2 The system shall be calibrated and tested prior to sailaway to the mating site

14.3 ENVIRONMENTAL MONITORING

14.3.1 The environmental monitoring system has two primary functions:

- To confirm that conditions are suitable for the docking and mating operations to proceed.
- To provide input for the vessel or barge's DP system (if applicable).

The secondary function is to predict weather and environmental trends prior to and during the float-over installation.

14.3.2 The environmental conditions which require monitoring are:

- Wind speed and direction
- Wave and swell heights and periods
- Current speed and direction
- Tidal height against time.

14.3.3 A tide gauge should be installed in the field, as close to the host structure as is practical, and should be monitored for at least two tide cycles before installation to allow actual levels and cycle times to be compared with predictions. During installation corrections derived from this comparison shall be used in conjunction with visual readings of the level marks on the host structure legs. A tide gauge may also be fitted to the host structure for reference purposes.

14.3.4 An infield directional wave rider buoy and associated hardware recording wave height, direction, period and spectral energy shall be considered for use to enhance operability of operations.

15 MARINE OPERATIONS PROCEDURES

15.1 PRINCIPLES

15.1.1 If the marine operations (Loadout, Transportation, Float-over) are performed by different contractors, then the scope split between the contractors must be clearly defined, to ensure that all parties are aware of their responsibilities, handover points and reporting lines.

15.1.2 The installation procedure shall include detailed step by step procedures and contingency procedures for each phase of the installation operation including all operational and limiting environmental conditions e.g. minimum and maximum tidal heights at all stages of the float-over operation. Required weather windows for critical float-over operations shall be stated, referenced to detailed hourly installation schedules.

15.1.3 Allowable environmental criteria and barge motions shall be established for each phase of the installation by analysis. The decision to proceed from one phase of the installation to the next shall be based on a comparison between the allowable environmental criteria for the next phase, the data obtained from the environmental monitoring systems, MRU and weather forecasts.

15.1.4 The start of the barge docking procedure may consider a specific period of the tide cycle. However, after the installation barge is docked in the slot, the installation setup should be able to ensure the installation can proceed safely for any specified tide.

15.1.5 Criteria for stopping or aborting each stage of the operation, and a critical “point of no return” for the float-over installation shall be identified.

15.1.6 The installation crew shall be fully trained on the details of the installation procedures and the operation of all related equipment.

15.1.7 Detailed installation barge mooring and anchor running procedures shall be developed taking due account of the AHV and assist tugs being provided.

15.1.8 A readiness meeting shall be held shortly before the start of float-over, attended by all involved parties.

15.2 WEATHER FORECASTING

15.2.1 A weather forecasting service should be used as a safety planning tool and an aid to decision making. The weather forecasting service provider should be agreed by all relevant parties.

15.2.2 A weather forecast from an approved source, predicting that conditions will be within the prescribed limits, shall be received prior to the start of the operation, and at 12 hourly intervals thereafter, or more frequently if appropriate, until the float-over operation is complete and the barge has been un-moored from the host structure.

15.2.3 Whenever possible a second forecast should be obtained from an independent source prior to installation.

15.3 INSTALLATION MANUAL

15.3.1 A comprehensive Installation Manual shall be written to identify all aspects of the operations in detail, cover all likely contingencies and specify exactly how the float-over will be conducted.

15.3.2 The following information shall be included in the manual:

- Installation schedule (hourly)
- Installation and test plan
- Installation organisation
- Communication procedure
- Key contacts and installation personnel information
- Roles and responsibilities
- Safety (emergency response procedures)
- Environmental limitations
- Tidal and current predictions
- Weather forecast procedure
- Operability studies
- Support facilities and vessel information
- Preparation check lists
- Pre-departure activities
- Pre-docking activities
- Docking operation
- Mating operation
- Un-Docking operation
- Installation related drawings
- Ballast procedure
- Change procedure
- Installation sequence drawings, anchor patterns and catenaries
- General arrangement drawings of LMU, LSF, seafastenings, fenders
- Detailed make up drawings and specifications of all mooring lines and tethers
- Specifications for all installation equipment and systems

16 MANAGEMENT AND ORGANISATION

16.1.1 Sufficient management and resources shall be provided to carry out the operation efficiently and safely.

16.1.2 Management resources of interested parties shall always be available with the right authority level to monitor any decision made during the installation operation.

16.1.3 Quality, safety and environmental hazards shall be managed by a formal Quality Management system including risk assessments, HAZOPs, HAZIDs and project familiarisations for key personnel.

16.1.4 Risk assessments, HAZOP/HAZID studies shall be carried out by Contractor in the presence of Client, MWS, and actual Contractor's operational personnel. The results shall be documented and agreed by GL Noble Denton. These studies shall be completed at an early stage so that the findings can be incorporated into the operational procedures.

16.1.5 The management structure and safety management system, including reporting and communication systems augmented by specific safety procedures, emergency response procedures and change management procedures shall be demonstrated to be fit for purpose and in operation.

REFERENCES

[1] GL Noble Denton 0013/ND - Guidelines for Loadouts.

[2] GL Noble Denton 0015/ND - Concrete Offshore Gravity Structures - Guidelines for Approval of Construction, Towage and Installation.

[3] GL Noble Denton 0027/ND - Guidelines for Marine Lifting Operations.

[4] GL Noble Denton 0030/ND - Guidelines for Marine Transportations.

[5] GL Noble Denton 0032/ND - Guidelines for Moorings.

[6] ISO 19901-5 – Petroleum and natural gas industries – specific requirements for offshore structures – Part 5: Weight control during engineering and construction.

All GL Noble Denton Guidelines can be downloaded from www.gl-nobledenton.com

APPENDIX A - CHECK LIST OF INFORMATION REQUIRED FOR APPROVAL

A.1 STRUCTURE

A.1.1 Structural analysis reports, including;

- Structural drawings including any additional float-over/loadout steelwork
- Description of structural analysis software used
- Structural models and description of boundary conditions
- Loadcases including derivation of weights and contingencies
- Structural strength checks for members, jonits and connections
- Justification of any over-stressed items
- Detailed design of structure support points, padeyes, winch connection points
- Proposals for reinforcements if required.
- Host structure drawings and limiting design loadcases
- Weight report for structure and results of weighing operation
- Checks on the effect of any weight changes after weighing or final weight calculations on the float-over operation

A.2 SITE

A.2.1 Site plan, showing host structure position, infield pipelines, flowlines and subsea infrastructure document by recent reliable surveys.

A.2.2 Drawings showing heights above datum of host structure legs, LMUs, structure support points, barge, and water levels.

A.2.3 Recent bathymetric survey report of area adjacent to the host structure, related to the same datum as item A.2.2.

A.3 BARGE

A.3.1 General arrangement and compartmentation drawings.

A.3.2 Hydrostatic tables and tank tables.

A.3.3 Details of class.

A.3.4 Trim and Stability booklet.

A.3.5 Barge allowable still water bending moment and shear force values.

A.3.6 Allowable deck loadings and skidway loadings if applicable.

A.3.7 Specification and capacity of all mooring bollards.

A.3.8 Details of any additional steelwork such as grillages or winch attachments.

A.3.9 Structural strength checks for grillage, seafastening additional steelwork and load-transfer areas.

A.3.10 Details of barge pumping system.

A.3.11 DP system description, trial documentation and procedures (if applicable)

A.3.12 Barge boarding ladders (4 minimum) for the range of drafts in question and wave height range.

A.3.13 Office/control room container suitability and equipment.

A.3.14 Barge power sources (generators) and redundant equipment.

A.3.15 Method of fendering between barge and host structure showing any sliding or rolling surfaces.

A.4 PUMPS

A.4.1 Specification and layout of all pumps, including back-up pumps and control systems.

A.4.2 Pipe schematic and details of manifolds and valves where applicable.

A.4.3 Pump performance curves.

A.5 JACKING AND/OR WINCHING EQUIPMENT

A.5.1 Jack/winch specification.

A.5.2 Layout of jacking/winching systems including power-packs.

A.5.3 Layout of contingency systems.

A.5.4 Calculations showing friction coefficient and loads on attachment points and safety factors.

A.6 BALLAST CALCULATIONS

A.6.1 Planned date, time and duration of float-over, with alternative dates, tidal limitations and operational windows.

A.6.2 Ballast calculations for each stage showing;

- Time
- Tidal level
- Structure position
- Load on host structure and barge
- Ballast distribution
- Barge draft, trim and heel
- Pumps in use, and pump rates required
- Moment to change heel and trim
- Freeboard (to ensure no green-water on deck).

A.6.3 Stages to be considered shall include as a minimum;

- Pre-mating
- First contact
- Intermediate load transfer, initial range 10-60%
- Last contact
- Barge exit

A.7 MOORINGS

A.7.1 Limiting design and operational weather conditions for float-over

A.7.2 Mooring arrangements for float-over operation and barge/vessel standby position.

A.7.3 Calculations showing environmental loads, line tensions and attachment point loads for limiting weather condition for each stage of the float-over operation.

A.7.4 Specification and certificates of all wires, ropes, shackles and chains.

A.7.5 Specification for winches, and details of foundation/securing arrangements.

A.8 TUGS

A.8.1 Details of any supporting tugs including bollard pull, thrusters and towing equipment.

A.9 MANAGEMENT

A.9.1 Organogram showing management structure and responsibilities.

A.9.2 Location of key personnel.

A.9.3 Details of manning levels, showing adequate coverage for all operations and emergency procedures.

A.9.4 Times of shift changes, if applicable.

A.9.5 Weather forecast arrangements.

A.9.6 Communications.

A.9.7 Operation bar-chart showing time and duration of all critical activities including;

- Mobilisation of equipment
- Testing of pumps and winches
- Barge/vessel movements
- Initial ballasting
- Seafastening removal
- Float-over operation
- Barge/vessel removal
- Completion activities
- Decision points.

A.9.8 Specification of the environmental monitoring system.

A.9.9 Methods of monitoring barge level and trim, and ballast quantities.

A.9.10 Specification of the Motion Reference Unit.

A.9.11 If a computerised ballast control system is to be used, a description of the system, with back-up arrangements, shall be supplied.

A.9.12 Safety procedures.

A.9.13 Communications procedures and communications equipment.

A.10 CONTINGENCIES

A.10.1 Contingency plans shall be presented for all eventualities, including as appropriate;

- Pump failure
- Mains power supply failure
- MRU failure
- Environmental monitoring system failure
- DP system failure
- Ballast control or gauging system failure
- Failure of any other computerised control or monitoring system
- Mooring system failure
- Deteriorating weather
- Jacking system failure (if used)
- Access and egress
- Damaged barge/vessel