



Exploration & Production

GENERAL SPECIFICATION

STRUCTURAL

GS STR 401

Load-out, sea-fastening, transportation and installation of offshore structures
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1. Scope

This General Specification defines the conditions and methods which are required by COMPANY for load-out, sea-fastening, transportation and installation of offshore fixed steel structures.

The specification applies to "conventional" fixed offshore structures, such as:

- 3, 4, 6 or 8 leg piled jackets installed by crane
- Launched 4 or 8 - legged piled jackets
- Decks (whether pre-equipped or not) installed by crane or barge ballasting
- Modules.

This specification does not cover the installation of self-launched components such as columns, jack-ups, gravity-base platforms, etc. If necessary, these will be covered by a particular specification.

This specification shall be read in conjunction with the Particular Specification for the project.

Plastic design shall not be allowed.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
API RP 2A	American Petroleum Institute: Recommended Practice for Planning, designing and Constructing Fixed Offshore platforms
DNV	Rules for Planning and Execution of Marine Operations
BV – NI 183	Towage at sea of vessels or floating units
NDI Ltd – Report 0030/NDI	General Guidelines for Marine Transportations

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
I.A.L.A.	International Association of Lighthouse Authorities Regulations

Codes

Reference	Title
IMO A 749 (18)	Code on intact stability of all type of ships covered by IMO instruments

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS COR 350	External protection of offshore and related structures and equipment by painting
GS GEO 702	Requirements for design and installation of skirted foundations and suction anchors
GS STR 001	Weight monitoring and weighing of offshore units
GS STR 100	Fixed offshore platforms - General
GS STR 101	Design of offshore jackets and subsea structures
GS STR 102	Design of offshore topsides structures
GS STR 201	Materials for offshore steel structures
GS STR 301	Fabrication of offshore steel structures
GS STR 304	Fabrication of welded plate girders (W.P.G.)
GS STR 402	Anchorage for a support vessel on an offshore site
GS STR 404	Marine aspects for load-out, transportation, and installation of offshore structures
GS STR 431	Installation of piles for offshore steel structures – Driven piles
GS STR 432	Installation of piles for offshore steel structures – Drilled and grouted piles

3. Involved parties and responsibilities

3.1 Certification/Third Party authorities

The Particular Specification will define the Marine Surveyor, the Third Party Authority and/or Certification Authority and their respective responsibilities and scope during operations covered by this specification.

In particular, the following will be defined:

- The Authority responsible for checking/certifying the design of structures
- The Authority responsible for checking/certifying the construction
- The Authority responsible for checking/certifying one or all of the following operations:
 - Load-out
 - Sea-fastening
 - Transportation.
- The authority responsible for checking/certifying lifting and installation operations
- Interface tables detailing the scope, the interfaces and the documents to be submitted and approved shall be prepared.

3.2 Distribution of responsibilities

The distribution of responsibilities and the interfaces between:

- The COMPANY
- The various CONTRACTORS in charge of design, construction, load-out, transportation and installation
- The various Certification or Controlling Authorities

shall be defined as shown hereinafter unless otherwise noted in the Particular Specification.

In particular, for the load-out, sea-fastening, transportation and installation, the Marine Warranty Surveyor appointed by the COMPANY shall be responsible for checking/surveying/certifying as relevant :

- the design including but not limited to design criteria, cargo barge/vessel strength, stability, motions analysis, dynamic analysis during installation,etc,
- the procedures and operation manuals,
- the marine and installation operations,
- the marine equipment and support vessels (derrick barge, HLV, cargo barge, ship, tug, etc),
- the necessary equipment/aids used for the different operations and installation (jacking system, pushing/pulling system, water pumps, slings/shackles, moorings, etc),
- the transportation route,
- the environmental conditions,
- the weather forecast

The compliance with this specification and COMPANY Approval does not release the CONTRACTORS and the Authorities in charge of the work, inspection and/or the certification, from their own responsibility.

3.3 Safety

In order to protect the personnel and all equipment, the CONTRACTORS shall take all the necessary and preventive actions to fulfil the safety requirements in particular for the use of Personnel Protective Equipment (P.P.E.), safety harness, scaffoldings correctly erected and in good order, etc.

In particular, life vests shall be worn during the operations along the quay and on the vessel for the load-out, sea-fastening, transportation and installation.

3.4 Equipment and re-used steel components

For load-out or lifting operation using strand jacks system or equivalent, all cables shall be brand-new and clean before the operation. At least one full spare strand jack unit with brand-new cables shall be provided.

For critical operations such as a float-over, all the synthetic hawsers shall be brand-new with certificates including for all the tug ones.

All equipment and re-used steel components to be used shall be in good order.

For hydraulic jacking system,

- any re-used/not brand-new jack or hydraulic power unit (HPU) shall be completely refurbished with new gaskets and seals.
- At least one spare jack for each type and one spare HPU shall be provided and kept immediately available with sufficient spare oil quantity at fabricator and offshore sites.
- In presence of MWS, of COMPANY and of a Certifying Authority appointed by TIC and approved by COMPANY, performance and calibration tests shall be performed for all the jacks and HPUs with new and clean oils and lubricants.
- After tests, the used/contaminated oil shall be analysed and replaced by new oil compatible for the long storage and idle period.
- A long duration running test of at least 72 hours shall be performed to simulate the degradation of the oil quality and system performance with respect to the running time, oil temperature, heavy jacking operating loads and relevant climatic conditions at fabricator and offshore sites.
- In case of use of the jacking system during the load-out, the used/contaminated oil shall be analysed and replaced by new oil for the final use on offshore site.
- A detailed testing, operating, maintenance and cocooning manual shall be provided with the relevant Failure Mode Analysis of the full hydraulic jacking system and control system.

Prior to any re-use, all equipment or steel components such as, but not limited to, substructures, skid beams, barge grillage, spreader frames / beams, jacking / pulling systems, etc. shall be submitted to the COMPANY approval.

Material certificates shall be supplied.

An associated inspection program shall be submitted to COMPANY approval. In particular, it shall be developed in line with, but not limited to, **GS STR 201** Table 4.1 and **GS STR 301** chapters 10.2 and 15 requirements.

Re-use of bolts is strictly prohibited.

Equipment and jacking system maintenance, cocooning and protection during fabrication and transportation shall be performed by skilled qualified personnel, and in accordance with the schedules and instructions supplied by MANUFACTURERS.

Equipment and jacking system testing and inspections shall be carried out by appropriate skilled and qualified personnel.

3.5 Load tests and test intervals

Test intervals shall not exceed one year.

3.5.1 General

Any equipment used for personnel transfer shall be tested every six months and baskets shall be tested every three months.

A new test shall be made in case of major repair or of replacement of an essential part, or of a modification, or of a reassembly.

Very particular case shall be taken for special handling using hired equipment which shall be tested in situ with its foundations and checked with respect to its design limitations (load, radius, wind, differential settlements, etc.).

CONTRACTOR shall demonstrate that such hired equipment is in good order, maintained and inspected according to the MANUFACTURER maintenance program, and properly insured with a clear definition of the responsibilities.

For jacking, lifting, pulling or pushing equipment, load tests shall be performed and witnessed by a Third Party Authority, the MWS and COMPANY.

3.5.2 Crane used on Construction yards

Contractor has to comply with the national regulation. But, in any case overload test shall not be older than one year.

For a crane, the load test shall be performed with the max. hook capacities at both maximum and minimum lifting radii in the same configuration (i.e. revolving , tie-back, etc.). This must be performed for all the hooks.

If the crane has been dismantled for transportation and re-assembled before entering one of our sites, the crane shall be load tested again (with overload).

If the crane configuration (boom length, fixed jib adjunction or fly-jib set-up) is modified in between our operations, the crane shall be load tested in that particular configuration.

All safety devices installed on the crane shall be in good working order. Safe Load Indicator, angle and radius indicators, anti-two-block device are required and shall be fitted up.

Hoist lines shall be fully and thoroughly inspected annually.

3.5.3 Offshore cranes and crawler or telescopic cranes installed on a barge.

a - Crawler or telescopic cranes installed on barge.

Crawler cranes and telescopic cranes on outriggers, temporary or permanently installed and used on barge shall be annually inspected and load tested according to 3.5.2. The standard load charts of these cranes are not valid for this utilisation and specific load charts for offshore (crane mounted on floating vessel or barge) shall be provided by the

crane manufacturer. On this load chart shall appear the Serial Number of the crane and the operating limitations.

b - Offshore cranes.

Contractor has to comply with:

Case 1: Last load test with overload dated less than 1 year

No particular requirement from the Company with the exception that derrick cranes (on lifting barge) or offshore pedestal cranes shall be inspected by Company.

Case 2: Last load test with overload dated more than 1 year and less than the 4 or 5 years regular time.

Company requires a functional load test representative to and in similar conditions with the planned lifting to be performed for our project (lifted load taking into account the Dynamic Amplification Factor, radius, hook block to be used, crane rotation...).

This test shall be witnessed by Company representative or appointed Third Party.

To be noted: the purpose of this test is to be sure that the crane is fit for purpose and ensure that all mechanisms and safety devices are well functioning. This test is not an overload test and the test load shall not be heavier than the Safe Working Load of the crane. Therefore it will never reduce the lifetime of the crane or increase the risk of deterioration by overload.

Derrick cranes on lifting barge, offshore pedestal cranes shall be inspected (thorough examination) by Company / appointed Third Party before the test.

If a similar lift has been safely done by the Contractor (lift representative to and in similar conditions with the planned lift to be performed for our project), within the last year, depending on the Contractor Quality Management Procedure and QA/ QC documentation (maintenance log book, operation log book, preventive and scheduled maintenance, inspection...) and the results of the visual crane inspection by Company, Company may validate this lift as the required functional load test.

Furthermore for all cranes with an offshore use Company requires an NDT check scheduled on a yearly basis and random before any heavy lift:

- 100% of the welds of the boom done in 5 years with a 20% rate per year,
- 5% of the most highly stressed nodes (boom, A-frame, central crane pivot...) by random check before any heavy lift,
- Hook rams and body before any heavy lift.

For all cranes with an offshore use, hoist lines shall be fully and thoroughly inspected annually. A sample of wire running on the sheaves of the hook block shall be cut from the dead end and subject to destructive tensile test. Results shall be provided to COMPANY.

If the crane hoisting lines are used for underwater lifting operations and the hooks are submerged, the maximum working life shall be less than 2 years. Without a specific cable maintenance procedure dedicated to subsea lifts and up to date log book, the hoisting lines shall be replaced.

3.5.4 Lifting ancillaries

Lifting ancillaries such as slings, shackles spreader bars, lifting beams, etc. shall be tested every year and thoroughly examined/inspected by a competent surveyor/Third Party Inspector.



The applied load test shall be :

- For slings and shackles : 1.25 x SWL
- For spreader bars & lifting beams : 1.50 x SWL

When the accurate knowledge of the slings length is required to reduce the skew load factor, the slings length shall be measured under tension with the intended factored load, as applied to the slings during lifting operation.

It is recommended not to use large diameters (>114 mm diameter) hand spliced cable laid slings. The use of this type of slings may result in failure of rigging system components, crane hooks and even lift package attachment points. The use of this type of slings shall be avoided in favour of the grommets or multiple part braids with flemish eye connection

Inspection certificates issued by a Third Party Authority of any lifting and handling equipment shall be no more than one year old unless otherwise required.

Slings should be marked with the following informations:

- Sling number or Contractor internal reference number
- Sling manufacturer
- Sling diameter
- Sling length
- Sling SWL
- Date of the last load test

3.6 Installation of equipment

For the load-out to be performed, all of the equipment necessary to perform and monitor the operation shall be installed, fully tested and calibrated prior to start the operation.

For the float-over installation to be performed, all of the equipment necessary to perform and monitor the float-over installation shall be installed, fully tested and calibrated prior to departure from load-out site. The equipment shall be tested again after arrival at the installation site prior to the start of the installation.

3.7 Training

CONTRACTOR shall fully train the load-out crew on the details of the load-out procedures and the operation of all the related equipment prior to start the operation.

CONTRACTOR shall fully train the installation crew on the details of the installation procedures and the operation of all the related equipment prior to departure from the load-out site.

A barge/vessel model shall be used to simulate the ballast tank arrangement, the configuration during the operation.

Distribution of responsibilities

1 - Load-out	CONTRACTORS							TP	CA	MS	WI	C
	E	F	W	L	S	T	I					
1.1 Supply and acceptance of means of transport and transport at yard entrance	R	R		R		P				A		A
1.2 Berthing and mooring of barge		P		A		R				A		R
1.3 Weight and centre of gravity calculated	P								R			R
1.4 Weight and centre of gravity measured during fabrication	R	P										R
1.5 Weighing	R	P	P				W/R		W/R	W/A		W/A
1.6 Services defined in 4.2.i and 4.2.j		P		P						R		R
1.7 Load-out procedure defined in 4.2	A	P		P		R			R	A		A
1.8 Load-out defined in 4		P		P		R				A		A
1.9 Load-out of accessories defined in 4		P		P		R				A		A
1.10 Load-out documents defined in 4		P		P					R	A		A
1.11 Load-out certificate defined in 8.2.3										P		

- CONTRACTORS in charge of:

- E Design Study
- F Fabrication/Construction
- W Weighing
- L Load-out
- S Sea-fastening
- T Transportation
- I Installation

- COMPANY C
- Marine Surveyor MS
- Third Party/Control authority TP
- Certification Authority CA
- Warranty Insurance surveyor wis WI

A = Approval - P = Carries out or supplies - R = Review - W = Witness - H = Hold Point

2 - Sea-fastening		CONTRACTORS							TP	CA	MS	WI	C
		E	F	W	L	S	T	I					
2.1	Barge grillage and sea-fastening documents defined in 5	P/R	P		R	P	A	R		A	A		A
2.2	Services defined in 5.3.i and 5.3.j		P			P					R		R
2.3	Technical file for sea-fastening (see 5.3)												
	Cargo barge + packages	A				P	P			R	A		A
	Packages on cargo barge	A				P	P			R	A		A
	Internal behaviour of the structure	P				P	R			A	A		A
2.4	Values to be taken into account for loading and sea-fastening calc. (see 5.4)	P					P			R	A		A
2.5	Barge internal reinforcement	A	P			P	A				A		R
2.6	Repair of areas damaged during loading and sea-fastening (see 5.5)	A	P			P	A				A		R

- CONTRACTORS in charge of:

- E Design Study
- F Fabrication/Construction
- W Weighing
- L Load-out
- S Sea-fastening
- T Transportation
- I Installation

- COMPANY C
- Marine Surveyor MS
- Third Party/Control authority TP
- Certification Authority CA
- Warranty Insurance surveyor wis WI

A = Approval - P = Carries out or supplies - R = Review - W = Witness - H = Hold Point

3 - Transportation	CONTRACTORS							TP	CA	MS	WI	C
	E	F	W	L	S	T	I					
3.1 Technical documents for transportation (sea-worthiness certificate, selected sea route, planning + personnel charts) see 8.2.2.4 and GS STR 404						P				A		A
3.2 Acceptance of transportation means										A		A
3.3 Transportation documents (see 5)	P					P				A		A
3.4 Certificate of Sail Away (see 8.2.4)										P		

- CONTRACTORS in charge of:

- E Design Study
- F Fabrication/Construction
- W Weighing
- L Load-out
- S Sea-fastening
- T Transportation
- I Installation

- COMPANY C
- Marine Surveyor MS
- Third Party/Control authority TP
- Certification Authority CA
- Warranty Insurance surveyor wis WI

A = Approval - P = Carries out or supplies - R = Review - W = Witness - H = Hold Point

4 - Installation	CONTRACTORS							TP	CA	MS	WI	C
	E	F	W	L	S	T	I					
The list herebelow corresponds only to activities where responsibilities may lead to discussions between CONTRACTORS entrusted with studies, manufacturing and transportation, and CONTRACTORS entrusted with installation. For the rest see chapters 6 and 7.												
4.1 Pile make up and driveability analysis (see GS STR 431)	P						A		A			A
4.2 Supply of slings and lifting shackles	R						P			A		R
4.3 Installation of slings and lifting shackles (see 5.6)		P					A			A		R
4.4 Supply and installation of temporary access ways to attachment areas		P					A			R		R
4.5 Fitting-out of cargo-barge, lifting barge						A	P			A		A
4.6 Mooring of cargo-barge, lifting barge						R	P			A		A
4.7 Cutting off of sea-fastening						R	P			A		R
4.8 Lifting operations							P			A		A
4.9 Return of cargo-barge						P				A		A

- CONTRACTORS in charge of:

- E Design Study
- F Fabrication/Construction
- W Weighing
- L Load-out
- S Sea-fastening
- T Transportation
- I Installation

- COMPANY C
- Marine Surveyor MS
- Third Party/Control authority TP
- Certification Authority CA
- Warranty Insurance surveyor wis WI

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4. Load-out

4.1 General

This Section refers to the load-out of offshore steel structures, including jackets, modules and components from the shore onto floating or grounded barges and ships. It applies particularly to skidded and trailer transported structures to be loaded onto floating barges in tidal waters.

This section shall be read in conjunction with spec **GS STR 404**.

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

The information and documents required by this Specification should be communicated to COMPANY in good time depending on the complexity of the method and of the item to be loaded out, but not less than twenty weeks before the load-out date.

For loading operations, the following shall be provided by load-out CONTRACTOR:

- The manpower
- The material
- The equipment
- Consumables, electrical power, etc.

required for loading operations, in particular cranes, skid-beams, bogies, rails, winches, jacks, idle pulleys, the guide or skid way systems, ballasting pumps, barge anchors, etc.

Load out operations shall be avoided during night.

The operation shall be tide independent. The tide effect shall be compensated by ballasting/de-ballasting in dedicated tanks on a complete tide cycle.

Intermediate stops or parking areas shall be considered and defined.

Only authorized persons involved in the load-out operations are allowed in the dedicated security zone and on the cargo barge or vessel.

The moving of the structure from fabrication area to quay side shall be considered as part of the Load-out.

4.2 Load-out procedure

A load-out procedure from the erection area onto the cargo barge or vessel shall be established by the CONTRACTOR and submitted to the Marine Surveyor and COMPANY for approval. This Procedure shall define (but not limited to) the following:

- a) The selected load-out method and load-out scenario: skidding, trailers, lifting, etc and associated requirements in particular for the skidways and bearing points on the deck structure (tolerances, vertical/lateral/longitudinal actions, guides, friction material, etc),
- b) The environmental criteria, measurements and monitoring: tide, current, water density, wind, local effect, traffic, deck advancement, foundation settlements, skidway beams/quay deflections, etc.
- c) The structure to be loaded

- d) The loads applied to the structure during load-out (intact, damage, uneven pulling, lateral loads, etc.)
- e) The interfaces design criteria necessary for the design of the skidways, interfaces, transverse stability beams, substructures between the skidways and the bearing points on the deck, peak loads on the quay, allowable deflections (short and long terms), etc,
- f) The barge ballasting/deballasting procedures and calculations, draft /trim /heel surveys and monitoring
- g) The site and quay capacity (peak load at quay, allowable deflections, etc)
- h) The skid ways (skid beams) and skid shoes, link beams
- i) The barge (strength, stability, etc.).
- j) The load-out equipment, material, additional structures and accessories, utility requirements (electrical, cooling water, Hydraulic Power Units, etc), control room, general arrangement, hydraulic pressures & strokes monitoring, the back-up devices, etc.
- k) Manpower, consumables, electrical power, HPU, cooling water, etc.
- l) Emergency procedure
- m) Load-out limitations: wind, uneven settlement/deflections/displacements, harbour traffic, etc.
- n) Load-out timing including margin
- o) The mooring during load-out and post load-out
- p) The load-out responsibility matrix
- q) COMPANY office and CONTRACTOR office close to the load-out area with the necessary furniture, telephone, electrical power, HVAC and documentation.

Important note: The load-out procedure shall include the necessary calculation notes to document all above items, their strength, the clearances, the specific tolerances. A Check List of information required to be included in the load-out procedure is given in the Appendix 1.

The back-up capacity for accidental conditions will be able either to complete the operation or to pull the object back to shore.

4.3 Structure to be loaded

The structure to be loaded, hereafter called the "object" shall be designed to withstand the static, environmental, uneven support level, uneven pulling/pushing loads, and friction loads experienced by the structure during the load-out operation.

The skew loads due to misalignment between the barge and quay skid ways or due to uneven ballasting or due to uneven jacking/pulling/pushing loads shall be considered. The values to be used for support out-of-level shall be indicated in the Particular Specifications.

Longitudinal and transversal stability shall be demonstrated with a minimum horizontal acceleration of 1 m/s² combined with the environmental loads. In addition, the extreme case with one compartment damaged shall be considered and combined with the above.

For trailer load-outs, the reactions imposed onto the structure by the trailer configuration shall be considered. The global stability shall be checked (bends, lateral loads, etc.)



Compatibility of support strength and elasticity against the support conditions used for analysis of the structure shall be demonstrated.

Consideration shall also be given to lifting off construction supports or onto sea-fastening supports when these operations form an integral part of the load-out operation.

The Weights and the Center of Gravity used for calculation shall be those determined by weighing.

The weighing of object shall be performed as specified in **GS STR 001** and/or as per Particular Specification.

In case the weighing is not possible, the weight and centre of gravity of each object shall be calculated with a great degree of accuracy prior to loading operations.

Details of the calculations shall be submitted for COMPANY approval twenty weeks prior to start the loading operations.

If the object is not weighed a contingency factor shall be conservatively applied to the computed weight. This contingency factor, depending of the accuracy of the Weight Control for all loads (structural loads, equipment loads, etc.), shall not be less than 1.10, unless otherwise indicated in the Particular Specification.

In case of use of a jacking system, a contingency factor shall be conservatively applied to the computed weight and dynamic loads. This contingency factor shall not be less than 1.15.

A COMPANY Reserve of about 10% shall be considered in addition to the calculated weight and applied at the same location than the centre of gravity.

Load-out analysis shall consider:

- The variation of the calculated location of the centre of gravity within a rectangle whose sides are equal to 5 % of the overall width and length for the jacket and 10 % of the overall width and length, but not less than within a 2 m x 2 m square area, for a deck.

The weight contingencies to be applied to derive the loaded weights shall be as follows:

- Same contingency as in weight report if the weight report is the reference for the load cases (maximum expected weight)
- A contingency equal to the weighing precision with a minimum of 3 % if a weighed weight is the reference for the load-cases.

Whenever the results of a weighing (if any) would show a weighed weight greater than the maximum expected weight and/or an excessive COG shift, the loading-out calculations shall be revised to consider the weighed weight and COG, and the structures shall be reinforced accordingly if required.

The load-out scenario must be documented in detail and all specific loads generated in the structure during load-out operation have to be identified. A calculation note shall be presented to COMPANY to demonstrate the acceptability of these loads and any corresponding reinforcement required, for the structure.

Any intermediate supporting element between the object and the ground shall be checked similarly, fabricated and inspected according to **GS STR 301** and classified in first category.

Stress levels shall be within those permitted by **API RP 2A**. One third increase for allowable stresses shall not be allowed for the normal case to be defined by the CONTRACTOR in considering a minimum vertical displacement of ± 30 mm between two adjacent supports. This value shall be documented by the CONTRACTOR in taking into account the levelling control

system and a reasonable achievable value. The details of the calculations shall be submitted to the Marine Surveyor, Third Party Authority and the COMPANY for review/approval.

When the load out procedure is not known (at basic engineering stage for instance), the load-out condition shall be covered by an analysis considering two cases:

- Normal case: a vertical displacement equal to ± 30 mm shall be imposed to each structure support points. These elementary support point deflections shall then be combined to cover any situation that can be met during load-out. The member stresses resulting from this analysis shall be compared to basic allowable stresses without 1/3 increase.
- Extreme case: each structure support shall be successively released (no support) or a maximum displacement of ± 60 mm shall be applied (three supports for a four point load-out arrangement and one row unsupported for a multipoint load-out arrangement); the member stresses resulting from this analysis shall be compared to the basic allowable stresses with 1/3 increase.

For a skidded jacket, as extreme cases, the structure stresses shall be checked for the following conditions as a minimum.

- The forward end of the jacket is cantilevered off the end of the fabrication yard skid ways and the cargo barge is ballasted to a depth lower than required. The critical position is when the center of gravity of the jacket is just at the end of the yard skid way.
- The forward end of the jacket is resting on the cargo barge but the center of gravity of the jacket is still not on the barge skid ways, and the barge is ballasted to a depth higher than required. This will lift the jacket forward end until the jacket is supported at the extreme ends of the jacket leg launch runner.
- The forward end of the jacket is moved onto the cargo barge until the jacket center of gravity is just on the barge skid way and the barge is ballasted higher than required. The jacket tailing end would be cantilevered off the end of the barge.

4.4 Site and quay

Documents (including additional calculation if necessary) shall be submitted to COMPANY showing the adequacy of the quay, quay approaches, wall and foundations for the load-out operation based on the proposed load-out scenario, the loads distributions along the skidways and the vertical and horizontal peak loads at quay wall.

Vertical jacks and anti uplift jacks shall be provided at the quay to control/monitor the cargo barge or vessel reactions at the stern or bow during the load-out.

Cargo barge or vessel stern (or bow) fenders shall be provided. They shall be connected to the skidways in order to transfer the axial and friction loads onto the quay wall.

The necessary wall fender shall be provided compatible with the axial/ friction loads and stern (or bow) fenders

Documents (including additional calculation, if necessary) shall be submitted to COMPANY showing the adequacy of all mooring bollards and other attachments to be used for the load-out.

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

Bathymetric information for area covered or crossed by the barge during load-out, post-load-out and sail way shall be supplied.

Under keel clearance shall not be less than 1.0 meter during the period for which the barge is along the load-out quay side.

Port authority approval for the operation shall be obtained by the CONTRACTOR and control of marine traffic shall be instituted whenever required.

4.5 Skid ways (skid beams), skid shoes and link beams

For each load-out scenario the loads to be supported by the skid shoes, skid ways and link beams (i.e. beams between quay and barge) shall be documented.

The compatibility between the strength and elasticity of the skid shoes/skid way assembly and the support conditions used for analysis of the structure (see Section 4.3 above), shall be demonstrated. Local web stiffening shall be provided at the point loads to avoid any buckling.

Link beams shall be checked additionally for loads induced by barge moorings, barge movements and pull/push on or pull/push back forces induced by load-out operation or emergency load off back to quay.

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

Alternative proposals and methods without link beams can be considered and can be approved if they are documented to comply with safe practice and all the above requirements.

The stability and capacity of the skid shoes and skid way assembly to withstand the loads experienced during load-out operation (differential settlement loads, uneven support level load, horizontal push-pull and friction loads, wind loads, lateral loads, stability loads, ballast loads, dynamic loads and to transfer these loads to the module, to the quay, to the link beams, to the barge, to the load-out equipment, etc. shall be demonstrated and calculation notes shall be submitted to COMPANY for approval.

Longitudinal and transversal stability shall be demonstrated with a minimum horizontal acceleration of 1 m/s² combined with the environmental loads and one damaged compartment.

Particular attention shall be given to the design and fabrication of the sliding interface, which shall withstand the planeity defects of skid shoes and skid beams and their relative deformations.

The grillage/skid beams on the cargo barge or vessel shall be installed with the cargo barge or vessel having the same shape than for the transportation static conditions

Ballast will be used to simulate the transportation static conditions.

The differential hogging or sagging of the ship due to different load/ballast arrangement at skidway beams installation stage shall be compensated.

The area corresponding to the transport location shall be checked to ensure that the supports are at the nominal elevation with a tolerance of +/- 5 mm. If not, shimming underneath the deck shall be required after load-out before jacking down the deck on its transportation supports.

4.5.1 Friction coefficients

The following indicative coefficients of friction may be experienced during load-outs with the various sliding surfaces as shown. The load-out CONTRACTOR shall substantiate the choice of friction coefficient and lubrication used in the load-out calculations.

Level surfaces	Static			Moving		
	Min.	Typ.	Max.	Min.	Typ.	Max.
Sliding						
Steel/steel	0.15	0.20	0.35	0.10	0.15	0.25
Steel/grease/steel	0.10	0.15	0.30	0.08	0.12	0.20
Steel/Teflon	0.10	0.15	0.25	0.04	0.05	0.10
Stainless steel/Teflon	0.08	0.10	0.20	0.03	0.04	0.07
Teflon/grease/planed wood	0.08	0.14	0.25	0.03	0.06	0.08
Teflon/grease/wood	0.10	0.18	0.30	0.05	0.10	0.15
Steel/wood	0.20	0.40	0.60	0.15	0.30	0.40
Steel/grease/wood	0.15	0.30	0.40	0.10	0.15	0.20
Rubber tyres (locked)	0.20	0.35	0.50	-	-	-
Rolling						
Steel wheels/steel		0.01			0.01	
Rubber tyres/steel	0.01		0.02	0.01		0.02
Rubber tyres/gravel	0.02		0.06	0.02		0.04

4.6 Trailer load-outs

Where trailers are used to move the object, the following shall apply:

- Maximum axle loading shall be shown to be within the trailer MANUFACTURER's recommended limits.
- "Footprint" pressure on the quay site, link beam and barge deck shall be shown to be within the allowable values.
- 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 limits.
- Transverse stability of trailers and intermediate piece of structure between trailers and object, shall be considered, specifically if movements other than straight line are planned for load-out operation.
- Longitudinal and transversal stability shall be demonstrated with a minimum horizontal acceleration of 1 m/s² combined with the environmental loads.
- The trailer arrangement shall be compatible with the support assumptions considered in section 4.3. above, and the barge grillage arrangement.

- When the trailers are winched onto the barge, then the requirements of Section 4.7 apply as well.
- Where motive power is provided by tractors, or the trailers are self-propelled, then the requirements of Section 4.7 shall be met and the reversibility of the motion shall be demonstrated.
- Adequate back up system shall be provided such that the load-out can still proceed in the event of failure of any one mechanical component, hydraulic system, control system, prime mover or power source.
- Particularly in case of multipoint load-out, special care shall be taken to ensure that the structure will come and rest in contact with all supports when the trailers are lowered and removed. Appropriate barge deck level survey and supports levelling shall be performed prior to load-out and required shimming, if any, anticipated. Due consideration shall be given to barge deck deformation with barge ballasting such that in tow condition the load-out supports are perfectly levelled. Jacking supports shall be provided to allow for levelling correction by shimming when the trailers are removed.

4.7 Winches and jacking systems

For moving the object, only one type of moving system shall be used: Winch System or Jacking System. CONTRACTOR shall provide additional pushing jacks to initiate the break-out. The overall pushing jacks capacity shall be circa 40% of the total break-out load in assuming a maximum static friction of 25% for a skidding operation,

Mixing systems is prohibited except for the break-out for which the assistance by jacking system is required. However, a different system can be used as emergency pull-back system.

The capacity of the winching or jacking system and the pull-back system, shall take into account the slope, the sliding or rolling friction and losses in sheaves. Except for grounded load-outs, a barge inclination of 1.0 % in addition to any planned inclination shall be accounted for.

A braking system capable of arresting movement of the object and a pull-back system capable of retrieving the module are required for all stages of load-out.

The winching system, when used, shall be capable of moving the object from fully on the shore to fully on the barge without rerigging.

There shall be sufficient winching or jacking capacity to continue moving the object after failure of any one component, system or power supply system.

Effects of the eccentricity of the loads shall be considered in the design of the skidways, substructures, transverse beams, etc.

The nominal computed load on winching systems shall not exceed 80 % the certified Safe Working Load (SWL), unless full capacity test has been performed, after allowance for splices, bending sheave losses, wear and corrosion and after taking into account the requirements of sections above. If no certified SWL is available, the nominal computed load shall not exceed $\frac{1}{4}$ of breaking load of any part of the system and a load test shall be performed at $1.25 \times \text{SWL}$ or $0.33 \times \text{MBL}$ prior to the operation.

Any winch or jacking system capable of exerting a greater force than the capacity of any other part of the pulling system shall be fitted with a cut-out to prevent the system SWL being exceeded, and the winch operator shall be clearly and formally instructed not to exceed the SWL of the system. Preferably, the complete pulling system (and any part thereof, including pulling eyes, tie bars and link-plates, multi-sheaves pulley blocks, shackles, pins, pulling wires, etc...) shall

be designed and justified for the full pulling capacity of the winch, even if the friction is anticipated to be much less than the pulling capacity.

The requirements for winching system given above apply to the jacking systems and to the trailers as well.

4.8 Lifted load-outs

The following shall apply when using shore-based or floating cranes for:

- Lifting the object, parts of object or heavy equipment onto the barge
- Lifting parts of object or heavy equipments on the yard during erection phase.

The lifting operation shall be within 80 % of the certified load-radius curve for the crane(s) proposed.

A minimum dynamic factor of 1.10 shall be considered.

Loads imposed by shore-based cranes on the quay shall be shown to be within allowable values.

All ground areas shall be carefully prepared with concrete pads and/or steel bearing mats to avoid any differential settlement and obstruction.

Slewing of the rear transporters shall be performed to check the preparation and capacity of its path.

Water level shall be installed on the crane or front transporter.

Lifting forces for a structure to be loaded out by direct lift onto the transportation barge should be evaluated if the lifting arrangement differs from that to be used for installation. In that case, appropriate dynamic, skew and safety factors shall be defined considering the expected local conditions, and the requirements of sections 6.2, 7.2.1 and 7.4.2 shall be satisfied.

Certified SWL of slings and shackles shall be in accordance with section 6.2.4.

When the offshore lifting points, spreader beams/frames are used for load-out, then 100 % visual inspection, 100 % MPI and 100 % ultrasonic inspection of the lifting points, spreader bars/frames and their connections with the structure shall be carried out before and after loading-out operation.

Means of preventing sway or rotation of the load during lifting and transit shall be provided.

4.9 The barge

(Refer to **GS STR 404**)

The barge shall be classed by a recognized Classification Society, and inspected by the Marine Surveyor and COMPANY.

Structural drawings and results of structural global analysis and local design shall be supplied to COMPANY to demonstrate the capacity of the barge to withstand the loads induced during the load-out and the compatibility with the assumptions used in sections above.

The stresses in deck and under deck framing, and welds shall not exceed the basic allowable stresses.

Mooring attachments and all attachments for jacking or winching shall be checked for the loads anticipated during and after load-out.

4.10 Pumping and ballasting

The load-out procedure shall allow for:

- Variations in level due to tides for a complete tidal cycle
- Variation in level due to local surge pending on the location configuration or other traffic
- Variation in cargo barge attitude, elevation and level during load-out operation.

The load-out procedure shall detail the calculations and systems, which allow for:

- Certain compartments to be ballasted and/or deballasted
- The transfer of water between ballast compartments
- The ballasting system should preferably have capacity to compensate for the tide through one complete tide cycle
- The transfer of water with the closed dock (if applicable) to maintain the level.

As far as possible, the compartments to be ballasted/deballasted for tide variations shall be different from the compartments to be ballasted/deballasted for draught, trim and list variations due to module position variation.

The compartments, which are not subject to ballast/deballast operations, shall be either full or empty, in order to avoid barge instability due to free-surface effects. Their levels shall be controlled before and also during the load-out operation.

A ballasting table based on tide variation, module position variation, pumps capacity and time shall be issued at least one month before load-out operation.

The effective tidal amplitude variation shall be surveyed during three weeks before load-out operation.

A ballasting decision table shall be provided in case of unforeseen event during the load-out.

For tidal load-out, sufficient pump capacity shall be supplied:

- To provide 200 % of the capacity required for the load-out, based on the maximum computed ballasting requirements
- To provide 150 % of the capacity required to maintain the barge at a constant level and attitude against the maximum rate of tidal rise or fall during the planned load-out period, assuming movement of the module is halted
- To provide 120 % of the capacity required for the load-out, after breakdown of any one pump or pumping system. Where two or more pumps are supplied from a common power source, this shall count as a single system.

All pumps and systems shall be tested during 24 hours at full capacity and shown to be operational 10 days before the start of load-out and tested again for two hours 24 hours before the start of load-out. At the discretion of the COMPANY representative, a verification of pump capacity may be required at any moment before the start of the load-out operation.

The ballast capacity of each compartment of the barge shall be surveyed before load-out and reported to COMPANY.

As far as possible, pumps shall be connected to compartments by mean of steel pipes and manifolds.

Whenever compartments access manholes would be obstructed by skid beams or grillage beams, these compartments shall be inspected and sealed before installation of beams, or temporary manholes shall be installed to allow for access.

The ballast and barge levels shall be monitored during load-out and shown to be within the limits as defined in sections above and within the structural limitations of the barge and module.

A minimum of one metre free board shall be maintained. Open manholes shall be surrounded by a coming plate (6 mm thick, 200 mm high) and all other manholes shall be properly sealed when the free board is less than 1 m.

4.11 Mooring

Limiting weather conditions for the load-out operation shall be defined, taking into account the forecast reliability for the area, the duration of the operation, the exposure of the site and 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 sea fastening.

Moorings for the load-out operation shall be designed for the limiting weather as defined in section above. All wires, shackles and other components shall be designed to the certified safe working load where applicable, or to a factor of safety of 3.0 on the breaking load.

Prior and after load-out, the moorings shall be designed to the 10-year return period storm for the area and season (three months period).

4.12 Grounded load-outs

Survey of levels over the area covered by the bottom of the barge showing suitable support conditions for the barge shall be performed by CONTRACTOR and submitted to COMPANY.

A diver or side-scan survey shall be made shortly before positioning the barge to ensure that no debris exists which could damage the barge bottom plating.

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

The barge shall be ballasted to provide sufficient ground reaction to withstand the 10-year return period storm loadings, in both pre- and post-load-out conditions, at mean high water spring tide and 10-year storm surge condition.

The barge should be positioned and ballasted onto the pad several tides before the load-out operation, and pre-loading ballasting shall be carried out, to allow for consolidation and settlement. Barge levels should be monitored during this time.

Final skid way levels shall be compatible with assumptions used for structural analysis as in section 4.5.

According to the nature of the sea-bottom, the installation of jetting or air-lifting devices in the area under the bottom of the barge may be needed prior to barge grounding to ensure the barge taking-off operation.

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

4.13 Accessory loading

Any accessories with coatings shall be loaded only by means of straps which do not risk to damage the coating. Therefore, the use of any jaws, chains, cables or any other equipment which could damage or distort the material, shall be prohibited.

Hardware, such as bolting, paint and cement, shall be loaded in a way which avoids any damage to packaging.

Any damage to coatings or packaging shall be made good.

4.14 Post load-out barge movement

In sheltered area, before to relocate the cargo barge along the quay, the object shall be secured in taking into account an horizontal force of 5 % of the object weight simultaneously in both directions plus a 15 m/s wind.

For exposed or open sea areas, COMPANY and Marine Surveyor shall define more severe conditions.

5. Transportation and sea-fastening

5.1 General

This Section shall be read in connection with **GS STR 404**.

This Section refers to the transportation of offshore structures, including jackets, modules and other industrial and marine equipment on cargo barges or heavy transport vessels from the shore to the installation site.

The Section cannot cover all aspects of every transport scheme. Alternative proposals and methods will be considered on their own merits and can be approved if they are documented to be in accordance with safe practice.

This Section does not cover the transportation in ice conditions.

In addition to the ARGOS beacon, for critical transportation and/or objects of more 5000 tonnes, a "blue box" (OCTANS equipment or similar) shall be provided during the transportation to monitor/record the motions, accelerations and headings. Not later than three months after the transportation, TIC shall analyse the results for some specific or severe events to be selected with COMPANY in order to evaluate the actual behaviour and motions of the vessel. The full set of the records and analysis shall be provided to COMPANY.

The whole transportation shall be performed under weather forecasts performed every 6 hours and as requested by two independent recognised international weather forecast companies provided by CONTRACTOR and to be approved by COMPANY and MWS.

In order to initiate and calibrate the system, the weather forecasts shall start two weeks before the sail away.

All the weather forecasts shall be transmitted to COMPANY and MWS.

Based on these weather forecasts, CONTRACTOR shall recommend the route and plan of actions for COMPANY and MWS approval.

5.2 Stability

During the basic design, for trans-oceanic and cyclonic area transportation no stability reduction based upon roll motions calculation is allowed by COMPANY. It is meant that a minimum of 36 degree and 40 degree of stability range is required for respectively Self Propelled Vessels and Cargo Barges.

During the detailed design when the Self Propelled Vessels and Cargo Barges are selected, if needed, consideration for reduction of the stability range based upon roll motions calculation shall be submitted to COMPANY for approval.

For local tow, if needed, reduction of the stability range based upon roll motions calculation shall be submitted to COMPANY for approval.

When roll motion calculations are performed, particular attention shall be paid to roll damping assessment.

When motion analysis is required to satisfy the stability criteria, particular attention shall be paid on the roll damping assessment to be addressed by model test if required and to be submitted to COMPANY for approval.

The stability analysis of a deck shall consider a variation of the calculated location of the centre of gravity of +/- 1m vertically, and shall consider the Company Reserve.

The information and documents required by this Specification should be communicated to COMPANY in good time depending on the complexity of the method and of the item to be transported, but not less than twenty weeks before the load-out.

The following shall be supplied:

- Barge(s) (or vessel) capable of providing high stability and balance during transport
- Barge (or vessel) deck and under deck strength to allow for load-out and transportation operations
- A sufficient number of tugs of adequate size and power to tow the structure safely under all 10-year sea conditions which could be encountered during the trip
- The equipment, consumables and supervision required
- ARGOS beacon on the cargo barges with regular position reports.

All formalities required by the customs and/or port authorities between the cargo barge departure and arrival points, including any stop-over which may be made shall be catered for.

5.3 Transportation and sea-fastening procedure

A transportation and sea-fastening procedure shall be established and updated by CONTRACTOR and submitted to the Marine Surveyor and COMPANY for Approval.

This Procedure shall define and document (but not limited to) the following:

- a) Detailed data including environmental in the sea zones to be crossed and on the installation site
- b) Maximum permitted weather conditions during transportation and for sea-fastening cut-off
- c) General arrangement selected for transportation

- d) The calculation of the loaded barge motions
- e) The structure and sea-fastening arrangement
- f) The stability of the object(s) (cargo) and barge assembly
- g) The barge structure and the barge grillage, including any internal and external barge reinforcement, if required
- h) Sea-fastening cut-off
- i) Additional equipment and accessories
- j) Manpower, consumables, etc.

Important note: The transportation and sea-fastening procedure shall include the necessary calculation notes to document all the above items, and in particular the effect of the barge flexibility on the object and sea-fastening design.

The CONTRACTOR is required to establish the transportation procedure in connection with the load-out procedure and check the compatibility between the load-out arrangement (skid ways, skid shoes, etc.) and transportation arrangement (barge grillage, sea-fastening, etc.) and installation requirements.

5.4 Applied loads

The structure to be transported, hereafter called the object, the strength of the barge and the sea-fastening shall be shown to be able to withstand the loads resulting from the transport condition, including:

- a) The loads generated by the object: static loads
- b) Loads resulting from vessel motion: dynamic loads
- c) Loads resulting from the design wind: environmental loads
- d) Loads resulting from direct wave action such as green sea, slamming, water on deck and other effects of immersion: environmental and dynamic loads
- e) The consideration of barge structure and barge grillage for local and global flexibility
- f) The consideration of the correct support conditions sequence for the calculations, i.e. non-fastened condition before connection of sea-fastening for static loads, and fastened condition after connection of sea-fastening, for dynamic and environmental loads.

Important note:

- The transportation analysis of a deck shall consider a variation of the calculated location of the centre of gravity within a rectangle whose sides are equal to 10 % of the overall width and length, but not less than within a 2 m x 2 m square area, and +/- 1m vertically.
- A COMPANY Reserve of 1500 metric tonnes in addition to the calculated weight and applied at the same location than the centre of gravity.
- In the load combinations for transportation analysis, the static loads should be taken into account for the object and barge arrangement without sea-fastening installed, while the dynamic and environmental loads should be taken into account for the object and barge arrangement with the sea-fastening installed.
- The horizontal components of the object loads resulting from the barge inclination shall be considered as dynamic loads.

- Fatigue shall be considered for long towages and for designs which are liable to suffer fatigue damage.

The environmental loads for transportation design shall correspond to the 10-year return period monthly extreme storm conditions for the period + two months, and over the worst section of the towage route, unless otherwise indicated in the Particular Specification.

If these values are not available and unless otherwise indicated in the Particular Specification, for standard configurations and subject to satisfactory marine procedures, the requirements of b) above will be satisfied by the application of the loads resulting from the following table and from a 25 m/s wind:

Type	Single amplitude (10 sec full cycle period)		Heave
	Roll	Pitch	
Large Barges or vessels (more than 90 m LOA)	20°	12.5°	0.2 x g
Small cargo barges	25°	15°	0.2 x g
Small vessels	30°	15°	0.2 x g

Notes:

1. Load cases should normally combine:

- $\pm$ roll $\pm$ heave
- $\pm$ pitch $\pm$ heave
- $\pm$ 80 % roll $\pm$ 60 % pitch $\pm$ 100 % heave
- $\pm$ 60 % roll $\pm$ 80 % pitch $\pm$ 100 % heave

2. Heave is considered to act along the global vertical axes.

3. Negative values may be as critical as positive values and particular attention should be given to the generation of uplift forces.

4. No allowance shall be made for friction to reduce sea-fastening forces.

5. 20 % shall be added to the loadings resulting from pitch motions to cover the effects of slamming.

Different values may be used, provided that these are justified by a study of the barge package assembly at the ten-year sea conditions or by tank tests.

The values used shall, in all cases, be approved by the Certification Authority and the various insurance Companies and COMPANY.

In order to satisfy the requirements related to a) to e) above, the following shall be considered:

- The nature of the cargo (object) structures and positions
- The nature of sea-fastening and grillage philosophy
- The proposed ballasting sequences
- The design storm.

For inland towages, where wave effects are expected to be negligible, the transportation requirements will normally be satisfied by considering a $\pm 0.1xg$ Heave combined with the more severe of:

- 5 Degree static angle in either roll or pitch direction
- Angle of inclination resulting from the worst one compartment damage condition, plus wind induced inclination and static wind loads resulting from the wind velocity specified as a 10-year storm condition.

For all cases, the loads used for transportation and sea-fastening design shall be approved by the Certification Authority, the Marine Surveyor and COMPANY.

No increase of basic allowable stresses shall apply for designing the object structure, the sea-fastening, the barge grillage and for checking or reinforcing the barge.

5.5 Sea-fastening

For sea-fastening operations, the following shall be supplied:

- The manpower
- The material
- The steel
- The equipment
- Consumables, etc.

The sea-fastenings have to be designed taking into account static, dynamic, and environmental loads as defined in Section 5.4. The calculation note for the sea-fastening arrangement shall be consistent with the transportation analysis of the object. Particular attention shall be paid to the design of the connection of sea-fastening with the structure and barge deck, including welds.

The sea-fastening and barge grillage shall be first category steel, and NDT of fillet welds shall be extended to 100 % MPI (see **GS STR 301**).

Sea-fastening work shall be started as soon as possible after positioning the object on the barge, but after the barge is ballasted for transport configuration.

No movement of the barge shall take place until sufficient sea-fastening is completed to withstand either the conditions for inland towage or the conditions for open sea towage, whichever is applicable. No allowance for friction shall be made at any stage of work completion.

A weather forecast from an approved source shall be received prior to the start of the load-out operation and at 12 hourly intervals thereafter until the barge is moored in accordance with Section 4.11. and the sea-fastening is completed in accordance with the requirements defined above in this Section.

When designing sea-fastening and barge grillage, the following shall be considered:

- Connecting components shall be fixed to the structure and to the barge. They shall comprise plates, rolled sections or pipes; the use of cables, prohibited for sea-fastening, may be allowed in certain cases for trimming, but open eye turn buckles are prohibited.
- Connecting components shall be positioned on rigid parts, both on the structures or packages and on the barge. If necessary, additional stiffeners or bearer/doubler plates shall be provided. Internal barge reinforcement shall be avoided.

- Connecting components shall be designed to allow progressive detachment of the structure. Connections of sea-fastening onto the object structure shall be performed using doubler plates.
- Doubler plates shall be 50 mm more (all around) than the dimension of incoming foot print and shall have 50 mm radius corner. Doubler plate thickness shall be documented.
- When necessary for high forces, doubler plates shall be annular plates with inner and outer welds.
- For punching shear checking, the equivalent diameter of the incoming brace with a doubler plate shall be the brace diameter plus 100 mm. No increase of the wall thickness of the chord or of the brace shall be considered due to the doubler plate without more detailed analysis.
- Due consideration shall be taken regarding the eccentricities of the sea-fastening braces with respect to the main nodes, and to the actual chord wall thickness where the braces are incoming.
- For long transportation and offshore stand-by, fatigue shall be documented.
- In the case of modules, arrangements shall be made to allow reattachment if installation is not possible at the first lifting operation.
- Before the barge leaves, any damage to paint during loading and sea-fastening operations shall be repaired.
- Offshore cut-lines, grinding and Non-Destructive Inspection requirements shall be defined.
- The repairs shall be made as stipulated in COMPANY and project Specifications.
- Internal sea-fastening for equipment shall be designed in taking into account the requirements of above paragraph 5.4, and the relevant lever arms.

5.6 Installation of slings for lifting at sea

The slings shall be, where possible, pre-installed at yard on the structures to facilitate the lifting of the jacket, deck or frames at sea. In that purpose, access and rigging platforms shall be designed and installed to support the slings and to facilitate the access to the sling eyes and lifting points, and to perform safely the removal of the slings and shackles.

The slings shall:

- Be well identified, with material and inspection certificates
- Be positioned to allow rapid lifting
- Be tied to the structure for transport
- Not be hanging inside of the object
- Be clear of any obstruction with a minimum clearance of 3 metres.

6. Installation studies

6.1 General

This section defines the minimum requirements to be fulfilled to analyse the structure of a deck, a module (including any package to be installed offshore) or a jacket for installation phases. The deck installation by ballasting (float-over) is covered in the following section 7.4.3.

It also covers the COMPANY requirements concerning the various hydrodynamic, stability, motion and floatability analyses to be performed to cover jacket installation phase.

This section shall be applied by the Engineering CONTRACTOR during all phases of design of a platform, and by the Installation CONTRACTOR for its particular checking and/or design engineering tasks.

6.2 Lifting studies

6.2.1 General

The purpose of the lifting studies is to check the structural behaviour of the packages to be lifted, and to calculate and design all the relevant lifting devices such as pad eyes, pad ears, trunnions, shackles, spreader bars or spreader frames, slings, bumpers and guides, etc.

This section defines the minimum requirements for jacket, deck or module (including any package) lifting studies. Depending of the destination of the platform, or of the selected installation CONTRACTOR, different methods and/or different acceptance criteria may be required by the Particular Specification.

Depending of the context of the study (basic engineering, detailed engineering, construction), the CONTRACTOR shall consider a more or less stringent contingency for the position of the center of gravity of the package to be approved by COMPANY.

This section covers the lifting operations performed with single or double hook lifting systems, single or double crane vessel lifting system. Other systems shall be covered by the Particular Specification.

Unbalanced prongs loads on the hook and hook tilt shall be addressed and approved by the crane manufacturer.

6.2.2 Lifting analysis

6.2.2.1 Computer model

The computer model used to verify the jacket structure at lift shall reflect the exact location of the application point of the sling force on the structure considering the eccentricity of pad eyes and slings.

The model shall be such that the center of gravity of the package and the hook point are in perfect static equilibrium.

6.2.2.2 Loads

For any lifting analysis, the calculations carried out shall combine and include the following loads and factors:

- For an unweighed structure, the calculations shall consider the maximum expected weight, which includes the contingencies defined in the weight report.

- For a weighed structure, the calculations shall consider the weighed weight plus a tolerance factor of 3 % due to weighing inaccuracy.
- When the maximum expected lift weight is above 90 % of the maximum lift capacity, the maximum lift capacity shall be considered for the lifting analysis.
- Whenever the results of a weighing (if any) would show a weighed weight greater than the maximum expected weight and/or an excessive COG shift, the lifting calculations shall be revised to consider the weighed weight plus 3 %, and the structure shall be reinforced accordingly if required.

Any lifting analysis shall consider the requirement stated in section 7.2.1 for jackets and section 7.4.2 for deck or modules.

6.2.2.3 Variation of COG

Lifting analyses during engineering phase shall consider:

- The variation of the calculated location of the centre of gravity within a rectangle whose sides are equal to 10 % of the overall width and length for a deck, and 5 % of the overall width and length for a jacket, but not less than within a 2.0 m x 2.0 m square area for a deck.
- The variation of the minimum sling angle of $60^\circ \pm 5^\circ$.

6.2.2.4 Dynamic Amplification Factor (DAF)

A dynamic amplification factor shall be applied for the design of the whole structure, the lifting points, the slings, the shackles and the spreader bars or frames, if any.

Weight of the lifted object	< 100 T	100-1000 T	1000-2500 T	> 2500 T
DAF offshore	1.30	1.20	1.15	1.10
DAF inshore	1.15	1.10	1.05	1.05

6.2.2.5 Skew load distribution (SKL) for single-hook lifts

In lieu of a more refined analysis taking into account the relative stiffness of the lifted object and slings, the lifted object and slings, the misfit and inaccurate sling lengths within the tolerances and other uncertainties with respect to the force distribution in the slinging arrangement, a skew load distribution shall be considered on any set of diagonally opposite slings.

The SKL distribution shall be applied for the design of the whole structure, the lifting points, the slings, the shackles and the spreader bar or frames.

- For statically indeterminate four points lifts with one of the following slinging arrangement:
 - Four slings directly from the four lifting points to the hook
 - Four slings to the hook with an intermediate spreader frame
 - Four slings to the hook with two intermediate rigid spreader beams.

It shall be considered:

Statically indeterminate four points lifts	Rigid object (jacket)	Flexible object (module)
Skew load factor SKL	1.50	1.33
Skew load distribution in any set of diagonally opposite slings	75/25 %	67/33 %

- For statically determinate four points lifts with one of the following slinging arrangement:
 - Four slings to the hook with two intermediate loose spreader beams
 - Two slings to the hook with one intermediate spreader beams.

It shall be considered:

- SKL factor = 1.10 i.e. a skew load distribution in any set of diagonally opposite slings of 55/45 %.
- For statically determinate three points lifts it shall be considered SKL factor = 1.

6.2.2.6 Other load factors for multi-hook lifts

In addition to skew load factors calculated in accordance with above requirements for single-hook lifts, it shall be considered the yaw and tilt effects which may result from a deviation of the hooks from their ideal relative positions.

In the absence of significant wind loading or tugger line loads, a minimum Yaw Effect Factor (YEF) of 1.05 shall be used.

When cranes are on the same vessel, the Tilt Effect Factor (TEF) shall be calculated for a tilt of 3° and for a tilt of 5° when the cranes are on separate vessels.

These factors shall be applied for the design of the whole structure, the lifting points, the slings, the shackles and the spreader bar or frames.

6.2.2.7 Consequence factor

A consequence factor equal to 1.35 shall be applied to loads for the design of lifting points, spreader bars/frames, incoming structural members connected to lift points, including their both extremities.

A consequence factor equal to 1.15 shall be applied to the rest of the structure.

For selection of slings and shackles, the consequence factor is not to be considered for evaluating the minimum SWL as it is included in the sling or shackle safety factors.

6.2.2.8 Allowable stresses

No increase of basic allowable stresses is allowed for lifting analysis.

6.2.3 Lifting points and incoming members design

The lifting points and incoming members shall be considered as special category components.

Lifting points and incoming members shall be designed using the sling loads resulting from section 6.2.2 or 6.2.3 plus an horizontal longitudinal and transversal load equal to 5 % of the

sling load mentioned above and applied at centerline for the trunnion or at top of the pinhole for the pad eye.

In case of lifting with 2-fold slings or grommet arrangement, a 55/45 % sling force distribution shall be considered on each part of grommet or sling, in order to take into account the friction on the trunnion or on the hook.

The position of lifting points shall be such that easy and safe access is ensured for installation and removal of slings, shackles, pins, etc.

The lift points shall be located at strong points on the structure, as symmetrically as possible around the COG position. The location of the COG shall be within an elliptic area centered on the geometrical center of the lifting points with large & small diameters equal to one-third of the corresponding distances between the lifting points.

The distance between the lift points shall not be less than half the overall dimension of the total module length or width to avoid a significant sling force increase by a small offset of the center of gravity.

The design of the pad eye/trunnion and its connections to the incoming members of the lifted object shall be based upon shear connection details, whenever possible.

The design of the lift point based on the transfer of stress in the through thickness of plates is prohibited.

For fabricated lifting points, the main plate rolling direction shall be in line with the sling direction. Lifting points drawings shall show the plate rolling direction.

The main plate shall be Z 35 quality.

6.2.3.1 Pad eyes

When cheek plates are used, they shall be on both sides of the main plate. Only one pair of cheek plates shall be used. The thickness of the cheek plate must be smaller than or equal to 75% of the main plate thickness: cheek plates shall be welded to main plates by a peripheric fillet weld and also by a 12 mm minimum partial penetration weld inside the pinhole when pinhole diameters are larger than 100 mm. The welds inside the pinhole shall not be considered for the calculation. If centralising rings are used on each side of the padeye, they shall not be welded to the cheek plates.

The radius of the main plate of the pad eye shall not be less than the maximum value of:

- $1.50 \times D$
- $D/2 + 3"$

D being the diameter of the pinhole

The cheek plate should be circular with the largest possible diameter. The radius of the cheek plate should be the radius of the main plate minus cheek plate thickness. The top of the fillet weld shall be clear of the corner of the main plate by 5 mm minimum.

The pin hole diameter shall be maximum 5 mm larger than the diameter of the pin for shackles with $SWL > 200\ T$ and 3 mm for $SWL < 200\ T$. Pin holes shall be machined to generally accepted fabrication tolerances.

The holes shall be line bored after the welding of the cheek plates to the main plate.

In addition to the diametral bearing pressure check, the Hertz pressure shall be checked for cylindrical bearing surfaces, and shall be limited to $2.5 F_y$, F_y being the smaller yield strength value when parts in contact have different ones.

Centralizers plates shall be used to limit the gap between the pad eyes and shackle yaw to 5 mm both sides.

6.2.3.2 Trunnions

The trunnion central main plate (shear plate) shall be slotted through the main tubular or plate the trunnion is attached to, and shall be designed to transfer the total sling load into the main tubular or plate, not taking into account the trunnion.

The trunnion should only be regarded as a bent circumference for the sling eye.

Inside the trunnion, stiffener plates are to be provided to transfer the sling load into the main plate via bearing and shear respectively.

The main plate thickness shall be equal to or larger than the lifting stub stiffener plate.

As the sling will flatten out at the contact area during lifting, the width of the stub (groove) shall be 1.25 times the sling diameter plus 25 mm.

The keeper plate shall protrude approximately 100 % of the sling diameter at the bearing area pending on suitable retainer details and at least 100 mm above the bearing face of the trunnion.

For sling installation an overall clearance of 1.5 times the sling diameter is required between the keeper plate and the main tubular or plate stiffeners, chords and other projections.

To prevent movement of the slings a special locker sling retainer device shall be designed. This sling retainer shall be easy removable.

All sharp edges likely to damage the sling during handling and transportation shall have a minimum radius of 5 mm.

The minimum trunnion diameter shall be three times the sling diameter where the sling eye is on the trunnion and four times the sling diameter where the body of the sling is on the trunnion.

6.2.4 Slings and shackles

Slings and shackles shall be selected so that their MANUFACTURER's rated SWL is not less than the sling load calculated as per sections 6.2.2 and 6.2.3.

Due attention shall be paid to the use of bent slings around trunnion or hook. In such a condition, the breaking load of the sling shall be multiplied by a bending efficiency factor C_b equal to:

$$C_b = 1 - 0.5 \times (d_2/d_1)^{1/2}$$

Where:

d_1 = diameter of trunnion

d_2 = diameter of the sling

Bent slings around shackle are not acceptable for heavy lifts (> 1000 T).

Multi-shackle pin-pin arrangements are forbidden.

In case of multi-shackle pin-bow arrangement, spacers shall be provided as required so as to align the rigging system.

Any sling which has been previously bent shall not be used for direct tension without fold.

6.2.5 Installation aids

6.2.5.1 Rigging aids

Auxiliary lifting aids have to be prepared and installed:

- Cradles, lifting, and/or push-pull devices in such a position to ensure easy installation/removal of the pins, shackles, sheaves, etc., when the SWL of the shackle is greater than 200 T.
- Access platforms for an easy and safe access to each area where this is necessary, in particular to the reach rods of the ballasting valves and lifting points.
- Rigging platforms for supporting the rigging arrangement during the transportation phase and to ensure an easy access of the crane hook for lifting operation.
- Temporary handrails around rigging platform and safe guard lines along legs and braces shall be provided for safety of access.
- The rigging platform shall be designed to support the weight of the rigging (slings, shackles, spreader bar, etc.) plus an uniform distributed load equal to 5.00 KN/m².
- The connection of the rigging platform on the object shall be performed using fast release bolted clamps to allow for an easy removal in one piece. The rigging platform shall be self bearing when clamps are released.
- The rigging platform shall be preferably located close to the installation derrick barge.

6.2.5.2 Bumpers and guides

A guide system shall be designed to ensure a placement of the package within a final tolerance of max ± 25 mm out of the required designed position.

The following criteria shall be considered, W being the lifted weight of the package:

1. When approaching the required position, the limitations of movements of the module should be:
 - Vertical: ± 0.75 m
 - Horizontal: ± 1.50 m in any direction
 - Tilt: 2 degrees
 - Plan rotation: 3 degrees (when package is close to its final location).
2. When designing the guidance system (bumpers, guides, installation lugs, pins and buckets), the following structural requirements have to be taken into consideration:
 - The position of each element of guidance system will depend upon acceptable support points on the module, nodes being obvious locations.
 - Doubler plates shall be used for the connections of the guides on the receiving structure and on the module unless written approval by COMPANY.
 - The guidance system should be designed so that the guide elements fail prior to permanent deformation of any part of the module. For integrated guidance system any deflection must be within the elastic limit of the material.

- The connection into the object and the object members framing at the bumper or guide location, should be at least as strong as the bumper or guide.
 - The stiffness of bumper and guide members should be as low as possible in order that they may deflect appreciably without yielding.
 - Design of bumpers and guides should cope with easy sliding motion of bumper in contact with guide. Slopping members should be at an acute angle to the vertical. Edges and sharp corners should be avoided on areas of possible contact, and weld beads should be ground flush.
3. The design of the guide system shall be based on the following load criteria (W = object lifted weight):
- Vertical sliding bumpers
 - Horizontal force in plane of bumper (Fh): $0.10 \times W$
 - Horizontal force out of plane of bumper (friction) (Ft): $0.05 \times W$
 - Vertical force (friction) (Fv): $0.01 \times W$

Forces in all three directions will be combined to establish the worst design case.
 - Pin/bucket guides
 - Horizontal force on cone/end of pin (Fh): $0.05 \times W$
 - Vertical force on cone/end of pin (Fv): $0.10 \times W$ for secondary guides
 $0.20 \times W$ for primary guides

Horizontal force in any direction will be combined with vertical force to establish the worst design case.
 - "Cow-horn" type bumpers with vertical guide
 - Horizontal force in any direction (Fh): $0.10 \times W$
 - Vertical (friction) force (Fv): $0.01 \times W$

Horizontal force in any direction will be combined with vertical force to establish the worst design case.
 - "Cow-horn" type guide with horizontal bumper
 - Horizontal force in any direction (Fh): $0.05 \times W$
 - Vertical force on inclined guide-face (Fv): $0.10 \times W$

Horizontal force in any direction will be combined with vertical force to establish the worst design case.

Note: Basic allowable stresses without one-third increase shall be considered for integrated guide design and module checks. One-third increase shall be considered for non integrated guide design.

Placement forces on final supports : in absence of more specific study, a vertical impact factor of 1.5g shall be considered without the one-third increase of the Basic Allowable Stresses.

6.3 Jacket launching studies

6.3.1 General

The purpose of the launching studies is to analyse the behaviour of the jacket and the barge during the different phases of the launching operation. These studies shall consider an accidental case consisting in flooding a buoyancy compartment of the jacket.

This section defines the minimum requirements for jacket launching studies. Depending on the size and the weight of the launched jacket, more detailed studies with different acceptance criteria may be required by the particular specification.

The launching studies shall consist in:

- A 3D hydrodynamic analysis, which shall determine the movements and the resulting loads applied to the jacket and the barge on a time step basis from the start of the movement till the stable position in water.
- A 3D structural analysis, which shall determine and check the stresses imposed to the structure of jacket and barge by the movement and loads resulting from paragraph above.

The launching studies shall define the requirements for auxiliary buoyancy devices.

6.3.2 Hydrodynamic launching analysis

6.3.2.1 Computer programs

This analysis shall be performed using a proven and recognised computer program.

The computer program shall be documented and the following shall be detailed:

- Description of the different axis systems
- Description of input data, including default values, units, and relevant axis systems
- Description of outputs, including units and relevant axis systems.

6.3.2.2 Models and basic hypothesis

The time step for the analysis shall not be more than 2 s.

The models used for the barge, jacket, skidding-beams, rocker arms and the basic hypothesis, shall be documented in detail in the calculation note which shall include at least:

- Geometrical descriptions
- Mass and inertia descriptions
- Hydrodynamic coefficients descriptions
- Buoyancy compartments and volumes description, including definition and location of auxiliary buoyancy devices
- Description of boundary conditions (friction coefficient of skidding beams)
- Description of the initial condition for launching (trim angle, draft of barge, position of jacket on barge)
- The water depth
- The time step and the number of steps studied

- The description of the damaged case (one buoyancy compartment flooded giving the worst effect).

Note: Whenever possible, description shall be performed by means of figures.

6.3.2.3 Results

The following results shall be documented in detail in the calculation note, for each time step of the calculation:

- Position of the jacket versus barge (position of the jacket COG versus axis of rocker arms)
- Position of the jacket versus water surface and sea-bottom
- Vertical and horizontal velocities of the COG of the jacket and barge
- Reactions on rocker arms
- Buoyancy loads exerted on the jacket, including buoyancy moment
- Summary of overall forces and moments
- Stability criteria: position of center of buoyancy, metacentric height in two directions, and restoring moment
- Water line area criteria: principal inertia characteristics, angle between principal axis and axis system, position of barycenter of waterline area.

All these results shall be given for each time step by means of curves in function of position of jacket versus barge.

The following characteristics of the trajectory shall be documented by means of figures (one per time step):

- Trim of the barge, including bow and stern draught
- Position of jacket COG
- Slope of rocker arms
- Depth of lowest point of jacket top in water
- Depth of lowest point of jacket in water
- Horizontal and vertical velocities of the jacket COG
- Horizontal velocity of the barge COG
- Equilibrium position of the jacket
- Time since the start of the operation.

6.3.2.4 Acceptance criteria

The following criteria should be fulfilled:

- The depth of the lowest point of the jacket top should not be more than 30 % of water depth
- The position of the lowest point of the jacket above the seabed should not be less than 10 m (5 m for the accidental case consisting in a flooded buoyancy compartment)
- The relative velocity of jacket versus barge should be at least 1 m/s when the jacket tilts.

6.3.3 Structural launch analysis

The structural behaviour of the whole jacket during launching shall be checked by a static analysis based on the loads resulting from the hydrodynamic launch analysis described in section 6.3.2 above.

Each jacket position defined by the passage of stiff points of the launch frame in line with the axis of the rocker-arm shall be analysed.

These calculations shall also cover the local design and checking of the launch frames and ramps, for above mentioned loads, combined to a lateral load equal to 5 % of the jacket weight applied to one ramp.

Structural stresses shall be compared to basic allowable stresses.

The auxiliary launching devices such as pushing or pulling lugs, lateral guides, etc., shall also be checked in detail, unbalanced loads of 25/75 being considered.

Pushing or pulling lugs shall be designed against the maximum capacity of the pushing/pulling equipment, or against the load calculated with 1.50 times the static friction coefficient.

The hydrodynamic pressure local and global effects on jacket members shall be justified considering the maximum depth of member during launch increased by 1/3, but limited to site water depth.

The structural integrity and connections of the auxiliary launch devices such as buoyancy tanks, water tight diaphragms, etc., shall be demonstrated when submitted to launch loads such as hydrostatic pressure, impact loads, drag loads, etc. For buoyancy tanks, the design hydrostatic pressure shall correspond to two times the maximum water depth during launch.

The loads and stresses applied to the barge structure, including rocker arms, shall be shown to be within the allowable limits.

6.3.4 Model tests in basin

For critical launching cases, model tests in basin shall be performed (shallow water, low floatability, unconventional launch, etc.).

6.4 Jacket free float studies

The purpose of this free float studies is to analyse the behaviour of the jacket in a free floating position, whatever may be the method to install it (launch or lift).

The following results shall be given in the calculation note for intact jacket and for a jacket with a buoyancy compartment flooded:

- The position of the center of buoyancy
- The position of the axis of the jacket legs at top and bottom of jacket, versus the floatation line
- The restoring moments for various inclinations up to 6°
- The inclining moment required to immerge the top of jacket by 0.5 m
- The metacentric height in two directions
- The water line area criteria.

The following requirements shall be considered:

- In shallow water depth and critical situations, the floatability of the jacket shall exceed the jacket weight by 20 % for intact jacket and by 12 % for damaged jacket with a flooded compartment. For other situations, these values may be reduced to 15 % and 8 % respectively.
- The restoring moment shall be positive for a tilt up to $\pm 6^\circ$.
- The inclining moment to immerge the top of jacket by 0.5 m shall be less than the corresponding restoring moment.
- The metacentric height shall always be positive and larger than 1 m.

6.5 Jacket upending and setting studies

6.5.1 Jacket upending assisted by crane

6.5.1.1 General

The purpose of the crane assisted upending studies is to analyse the behaviour of the jacket and obtain the hook loads and the ballast program during the operation from the free float position to the vertical position. This shall be achieved by performing a 3D hydrodynamic analysis covering at least 10 intermediate steps.

6.5.1.2 Computer program

The hydrodynamic analysis shall be performed using a recognised and proven program, which shall be documented as follows:

- Description of different axis systems
- Description of input data
- Description of output data, including units and relevant axis system.

6.5.1.3 Results

For each intermediate step, the following results defining the equilibrium position shall be given:

- Total ballast configuration per compartment
- Variation of ballast configuration versus previous step
- Hook load, and sling loads
- Roll and pitch angles
- Bottom clearance with seabed
- Metacentric height according to both axis
- Positions of center of gravity and center of buoyancy
- Position of jacket versus the water line (reference point shall be the same as for marking of jacket legs).

These results shall be summarized by means of tables and curves versus the position of jacket for each step.

6.5.1.4 Acceptance criteria

Metacentric height shall be positive and greater than 1 % of the water depth.

Bottom clearance shall not be less than 5 m.

Acceptable hook loads:

- If the jacket weight in air is less or equal to crane capacity, the allowable hook load is taken as equal to the crane capacity.
- If the jacket weight (in air) is comprised between 1 and 1.5 times the crane capacity, then the allowable hook load shall be taken as 2/3 of the crane capacity.
- If the jacket weight (in air) is greater than 1.5 times the crane capacity, then the allowable hook load shall be taken as 1/3 of the crane capacity.

6.5.1.5 Structural checks

Jacket structure shall be checked considering the hook loads resulting from the hydrodynamic analysis.

Jacket members and auxiliary buoyancy devices shall be checked against hydrostatic pressure as per section 6.3.3.

The lifting points shall take into account the sling angle variation during the upending, and additional lateral force of 10 % of the sling load shall be applied to the top of the pinhole.

The shackles shall be selected using an additional safety margin of 1.5.

6.5.2 Upending by ballasting

6.5.2.1 General

The purpose of the upending by ballasting studies is to analyse the behaviour of the jacket and to obtain the ballasting program for the operation from the free float position to the vertical position.

This shall be achieved by performing a 3D hydrodynamic analysis considering at least one step for each 10° inclination.

The stability and the position of the jacket shall be checked according to the same principles as for the crane assisted upending, section 6.5.1.

6.5.2.2 Acceptance criteria

The metacentric height shall be greater than:

- 0.2 m
- $0.002 \times \text{jacket height for inclined position}$
- $0.01 \times \text{jacket height for vertical position}$.

The bottom clearance with the seabed shall be greater than 5 m.

6.5.2.3 Structural checks

Jacket members and auxiliary buoyancy devices shall be checked against hydrostatic pressure as per section 6.3.3.

6.5.3 Jacket setting on the seabed

The purpose of the setting studies consists in analysing the behaviour of the jacket during setting, and issues the setting procedure in order to control the operation on a step by step basis. Each step represents a one meter lowering.

The calculation note shall be carried out as per the requirements of section 6.5.1.

7. Installation operations

In this chapter, the "CONTRACTOR" means the CONTRACTOR responsible for installation operation.

Derrick barges and cargo barges to be used shall be classed by a recognized Classification Society, and inspected by the Marine Surveyor and COMPANY.

However, the Engineering CONTRACTOR and the Fabrication CONTRACTOR shall consider the requirements of this section for the performance of their respective tasks.

7.1 Procedure, preparation

7.1.1 Procedure

Four months before commencing installation of the structures, the CONTRACTOR shall submit for COMPANY approval a detailed procedure describing:

- a) The site seabed reconnaissance and identification operations proposed.
- b) The data, specifications and drawings of the lifting barge to be used. In particular, this includes the stability calculations for the barge, the length and size of the anchor lines and the size and shape of the anchors. The mooring calculation shall account for one anchor line failure using 10-year return period for a three month period.
- c) The data and drawings of the cargo barge(s), including the planned unloading arrangements along with the planned configuration of anchors and anchor lines, etc., including clearances.
- d) The drawings, specifications and calculations for the jacket or deck or module installation procedure.
- e) The method planned for installing the piles, including pile driving in add-ons, the equipment to be used (including back-up equipment), the capacity of the hammer(s) with the forecast driving curve and the maximum pile stick up length, drilling procedures and grouting procedure (including interstices checks).
- f) Technical documents concerning welding operations: welding procedures, welder qualifications and non-destructive inspection procedures.
- g) Technical documents concerning the lifting and installation of the deck, the modules, the mooring point and any other structures. These documents shall, in particular, include the drawings and calculation notes for lifting lugs, lifting beams and lifting equipment, including lifting scenarios according to the lift weight and COG location indicating approach dimensions and under-hook heights.
- h) A list, complete with the technical specifications, of the equipment used to check the installation position and tolerances. This procedure shall clearly define position of datum points.
- i) A study defining the allowable sea states for installation of jacket and decks.

- j) Detailed planning of the various operations.
- k) The latest updated data concerning weight and center of gravity shall be included. These data shall consist in the final weight report and the final weighing report if the package is weighed. Any deviation between weight report and weighing report shall be clarified.
- l) The lifting arrangement and all the lifting aids definition with their tag numbers (slings, shackles).
- m) The ballasting requirements before lifting operations.

7.1.2 Preparation

7.1.2.1 Of the Jacket

- Marking

Leg numbers shall be painted at top and bottom of each leg. Slot numbers shall be painted on conductor guides at each jacket level.

Level markings every 0.5 m shall be painted at top of each leg in the splash zone as a minimum, using CD = L.A.T. as zero reference, unless otherwise defined.

For corner legs, level markings shall be performed every meter on the whole remaining length of the leg.

Level reference shall be marked every 5 m. Flood valves protectors shall be painted in white.

- If a ballasting system is used, the CONTRACTOR shall insure that the controls are accessible, either at surface or to divers, and correctly protected against any environmental and operational risks. Open and close positions shall be clearly marked on ballasting valves and on remote control handles.
- At each end of pile or conductor pipe sections, longitudinal welds shall be painted.

7.1.2.2 Of lifting accessories

The CONTRACTOR shall ensure that the lifting accessories shall be clearly identified, certified and installed according to the approved installation drawings

7.1.2.3 Of the site

The CONTRACTOR shall mark the final positions selected for the structure by a location system. The CONTRACTOR shall place a marker buoy, anchored if necessary.

The CONTRACTOR shall carry out a seabed surface survey prior to the installation operations starts.

This survey shall be at the CONTRACTOR'S expense, and shall be done by divers or any other means subject to the COMPANY'S approval. The zone survey shall be submitted to the COMPANY'S approval. Any debris or obstacles which could hinder the installation of the structure shall be removed during this survey.

The location system and the marker buoy shall be approved by COMPANY.

Special precautions shall be applied if the installation works are to be carried out close to existing platforms:

- The CONTRACTOR shall submit the final layout drawing to the COMPANY's representative's approval before installing the anchors and anchor lines.
- During installation, the CONTRACTOR shall take all precautions required to avoid damaging either existing pipelines or platforms or free-standing pipes, or any other subsea installations.

Clearances shall be clearly defined and submitted to COMPANY for approval.

If the platform is to be installed over an existing well, the CONTRACTOR shall provide a guiding and a wellhead protection system to prevent any damage due to accidental contact with the jacket.

Under no circumstances shall the CONTRACTOR moor his barges to surrounding platforms.

If the site is such that it is not possible to achieve the installation of the anchor system required, the support ships shall be orientated relative to predominant winds or currents such that, if the anchor drags, the barges move away from the structure.

7.1.2.4 Clearances

As a minimum, or unless otherwise approved by COMPANY, the following clearances should normally be maintained at each stage of the operation in addition to the relative motions between the derrick barge and the cargo barge or platform:

7.1.2.4.1 Clearances around lifted object

- 3 m between any part of the lifted object (including spreaders, slings and lift points) and crane boom
- 3 m vertical clearance between the underside of the lifted object and any other previously installed structure, except in the immediate vicinity of the proposed landing area
- 3 m between the lifted object and the barge grillage, sea-fastening or other structures on the same transport barge
- 3 m horizontal clearance between the lifted object and any other previously installed structure, unless purpose-built guides or bumpers are fitted
- 3 m remaining travel between travelling block and fixed block at maximum load elevation.

7.1.2.4.2 Clearances around crane vessel

- When the crane vessel is moored adjacent to an existing platform, 3 m between any part of the crane vessel and the platform, and 10 m between any anchor line and the platform
- When the crane vessel is dynamically positioned, 6 m nominal between any part of the crane vessel and the platform
- 3 m between crane vessel and seabed, after taking account of tidal conditions, vessel motions, increased draft and changed heel or trim during the lift.

7.1.2.4.3 Clearances around mooring lines and anchors

Refer to **GS STR 402**

7.2 Installation of the jacket

7.2.1 Lift installed jacket

The jacket installation procedure to be established by CONTRACTOR as per section 7.1 shall more particularly document the requirements listed hereafter as a minimum.

The crane shall have a sufficient certified capacity and the crane barge shall have a sufficient stability to allow for:

- Jacket lifting off from cargo barge
- Jacket upending in air or in water
- Jacket setting on the sea-floor
- Jacket levelling.

Sling shall be attached above the jacket's centre of gravity to avoid any damage, either to the jacket or to the barge, during lifting operations.

CONTRACTOR shall supply the drawings showing the jacket slinging points and centres of gravity and the capability of the crane used for the operations described above (installation scenario).

The CONTRACTOR shall take care to avoid any damage to the anti-corrosion or cathodic protection system, and make good any damage.

The jacket structure and the crane rigging shall be designed to withstand all the phases of the installation listed above. If jacket upending is planned, at least the three most critical intermediate positions to be agreed on by COMPANY between horizontal and vertical positions shall be studied.

The study concerning the jacket setting on the seabed shall consider the drag effect of the jacket members and equipments (mud-mats) in water.

Whenever the results of a weighing (if any) would show a weighed weight greater than the maximum expected weight and/or an excessive COG shift, the lifting calculations shall be revised to consider the weighed weight and COG, and the structures shall be reinforced accordingly if required.

Material and accessories intended to be used for installation operations shall be submitted to the Marine Surveyor and COMPANY for approval.

Lifting loads and lifting design shall be carried out as per section 6.2.

7.2.2 Jacked installed by launching

The launching barge shall be fitted with launching ramps, tilting arms, a controlled ballasting and deballasting system and a self-contained power supply to assist the structure to slide down the ramps.

The jacket shall be levelled following an accurate and detailed procedure. The ballasting and de-ballasting systems, the attachments points and the pad eyes shall be provided by the CONTRACTOR.

The CONTRACTOR shall ensure that there is a minimum clearance of 10 m between the jacket at its lower position and the mud line.

The jacket trajectory in the water shall be studied by means of a proven computer program to ensure that it will hit neither the barge nor the seabed.

The launching hydrodynamic analysis and structural analysis shall be performed as per section 6.3 of the present specification.

7.2.3 Levelling

The CONTRACTOR shall supply the procedure and all equipment required to correct the level of the jacket.

After installation of the first section of the first pile, the jacket shall be levelled to within the tolerances stipulated in paragraph 7.6. Respect of these tolerances shall be maintained throughout pile driving. Final adjustment shall be made after pile driving.

7.2.4 Intermediate phases

The intermediate phases of jacket installation are covered by sections 6.4 and 6.5 of the present specification.

7.3 Installation of piles

For installation of piles, refer to specification **GS STR 431**.

7.4 Installation of the deck and other frames

7.4.1 General

The deck (or other frames) installation procedure to be established by CONTRACTOR as per section 7.1 shall more particularly document the requirements listed here after as a minimum.

The CONTRACTOR shall check the distances between:

- The installed piles, after cutting off to level
- The deck legs.

The CONTRACTOR shall also check any significant dimension before installation to ensure that installation operations can be carried out in complete safety.

Lifting and handling operations or any other installation mode shall be carried out in line with the previously approved procedure.

During installation of the deck, care shall be taken to avoid damaging the piles, the deck or any equipment already installed on the deck or on the jackets. If damage does occur, the CONTRACTOR shall inform the COMPANY's representative and carry out any repairs in agreement with the COMPANY's representative.

Welded joints between piles and decks shall be 100 % inspected by ultrasonics, as stipulated by the procedure.

All weld inspection operations shall have been completed, to the COMPANY's representative's satisfaction before any demobilization of lifting cranes.

Once the deck has been installed, the CONTRACTOR shall install all ladders, handrails, landing areas and any other accessories.

Material and accessories intended to be used for installation operation shall be submitted to Marine Surveyor and COMPANY for approval.

7.4.2 Deck installation by lifting

Unless indicated otherwise in the particular specification, all lifting operations shall be carried out by a crane:

- Either using slings directly connected to the deck on three or four points
- Or using one (or several) lifting beams or lifting frames connected to the deck on three or four points.

The crane shall have a sufficient certified capacity and the crane barge shall have a sufficient stability to allow for:

- Deck/module/other frame lift off from cargo barge
- Other frame upending if applicable
- Deck/module/other frame setting on relevant support.

The lifting slings shall be attached above the deck/module/other frame center of gravity to avoid any damage during lifting operation.

On the hook, the sling arrangement shall be symmetrical to avoid a tilt of the block and an angle between the wires and the sheaves.

CONTRACTOR shall supply the drawings showing the deck/module/other frame, rigging points, center of gravity, installation scenario, and the capability of the crane used for operations listed above.

The deck/module/other frame structure and the crane rigging shall be designed to withstand all the phases of the installation listed above. If a frame upending is planned, at least the three most critical intermediate positions between horizontal and vertical positions shall be studied.

Whenever the results of a weighing (if any) would show a weighed weight greater than the maximum expected weight and/or an excessive COG shift, the lifting calculations shall be revised to consider the weighed weight, and the structure shall be reinforced accordingly if required.

When the maximum expected lift weight is above 90 % of the maximum lift capacity, the maximum lift capacity shall be considered for the lifting analysis.

Material and fabrication of lifting pad eyes, spreader bar and lifting devices, if any, shall be as specified in General Specifications **GS STR 201** and **GS STR 301**, special category member.

Lifting loads and lifting design shall be carried out as specified in section 6.2 of the present specification.

Tugger line pad eyes (50 T SWL) shall be provided on the edge of the object.

On the hook the slings arrangement shall be symmetrical to avoid the tilt of the block and an angle between the wires & the sheave. Unsymmetrical arrangement shall be addressed considering hook strength & displacements, to be approved by the crane manufacturer.

7.4.3 Deck installation by ballasting

7.4.3.1 General

This section refers to the installation by float-over of a deck to be performed from a floating cargo barge or vessel onto a pre-installed jacket.

This section defines the minimum requirements to be fulfilled to analyse the structure of the deck by float-over and to perform the installation in a safe manner.

Unless otherwise specified in the PPS, the float-over shall be a longitudinal one in open sea with entrance into the jacket by the stern of the cargo barge or vessel facing the predominant swell.

When DP mode is available, the approach of the vessel may be performed in DP 2 mode up to a distance of about 100 m from the pre-installed jacket or any other existing platforms.

The final approach and entrance shall be performed with the assistance of tugs, mooring lines and brand-new synthetic hawsers connected to the jacket.

Once in position into the jacket, the cargo barge or the vessel shall be maintained in position with respect to the jacket by a system of rubber fenders and constant pressure jacks or similar. The objective is to avoid any significant horizontal relative motions between the deck and the jacket legs during initial contact phase.

The use of synthetic hawsers only to control the horizontal motions (surge/sway & yaw) of the vessel shall not be accepted .by COMPANY.

The design of the system to be used to ensure an accurate positioning of the installation vessel with respect to the jacket as well as the system to be used for safe load transfer on the jacket leg shall avoid any significant dynamic amplification due to resonance effect or impact loads that may occur during transient phase and thus lead to uncontrolled situation and high loads. Time domain simulation of a coupled model shall be implemented to fully capture all the non-linear effects.

The float-over procedure shall be developed with the relevant allowable environmental conditions for each phase of the installation in order to be able to perform the operation in a fully controlled and safe manner.

7.4.3.2 Environmental monitoring and weather forecast

On a 24-hour basis, the whole installation operation shall be performed under weather forecasts performed every 6 hours and as requested during the installation by two independent recognised international weather forecast companies provided by CONTRACTOR and to be approved by COMPANY and MWS.

All the weather forecasts shall be transmitted to COMPANY and MWS.

The environmental data acquisition system on site shall include as a minimum:

- a directional Datowell buoy installed upwards and close to the site,
- a tide meter installed on a close existing platform,
- a current meter installed on a close existing platform,
- an anemometer installed on a close existing platform.

Environmental data acquisition and weather forecasts shall start at least two weeks before the time of arrival at the installation site in order to allow for a calibration of the models.

All the data acquisition shall be transmitted to COMPANY with the analysis not later than three months after the operation.

The full installation shall be preferably fully independent of tide. Only minor tide constraints can be accepted by COMPANY and MWS provided that safe stand-by conditions can be found at any stage, and that the total duration of operation is not significantly increased by the potential

necessity to wait on tide. Preliminary tide compensation method, procedures, ballasting tables shall be established by CONTRACTOR at the CONTRACT award and they shall be developed and detailed during the detail design.

The float-over operation is very sensitive to the environmental conditions and in particular to the wave period, wave heading and wave height.

Detailed hydrodynamic and motions analysis shall be performed to define the movements and relevant acceptable movements and clearances to be achieved at each step of the operation. The allowable environmental conditions shall be established for each phase of the installation and compared to the actual environmental measurements and motions before to proceed to the next step.

7.4.3.3 Float-over method

As the float-over shall be performed in open sea and facing predominant swell sea conditions, in combination to the cargo barge or vessel integrated ballast system capable of ballasting down or in emergency de-ballasting, CONTRACTOR shall develop a rapid and controlled load transfer of the deck onto the jacket to avoid damages due to impact loads during the mating.

Fully reversible hydraulic jacking system with a long stroke shall be preferably contemplated but other methods will be considered on their own merits and can be approved if they are documented to be in accordance with safe practice and the non return points are clearly identified.

At the CONTRACT award, CONTRACTOR shall:

- select and define the float-over procedure and associated requirements in particular to ensure a rapid initial load transfer from barge to jacket and a rapid final separation between the deck and the installation vessel. Such a system shall allow to close/create a sufficient clearance and to transfer a sufficient load to stop relative motion in less than one minute.
- define all the interfaces design criteria necessary for the design of the jacket & piles, deck, fenders system, moorings, etc. These requirements shall be considered by the ENGINEER in charge of the deck, jacket and piles design,
- define the float-over responsibility matrix in including the presence of the other existing facilities (platforms, pipelines, etc) on the field,
- select the cargo barge or vessel, define her main marine data (dimensions, lightship weight, location of centre of gravity, hydrostatic curves, cross curves, water tightness arrangement, sounding tables, min./max. drafts, etc.) and interfaces criteria.

CONTRACTOR shall be responsible for:

- all the relevant float-over design and documentation,
- the detailed design, supply, fabrication and erection of all the necessary float-over structures,
- the detailed design, supply, fabrication, erection and tests of all the necessary equipment to perform the float-over in a safe and controlled manner (jacking system, ballast system, fenders and positioning system, etc)
- the supply of the cargo barge or vessel with the sea-fastened deck at offshore site,
- the design, supply and installation of the mooring lines and the necessary anchoring points offshore and on the jacket to be installed onshore at the JF yard,

- the design, supply, fabrication and installation of all the necessary barge strengthening / grillage, external/internal reinforcements if any, fenders, sheaves, guides, anchoring points, etc.
- the performance of the float-over from the cargo barge or vessel arrival with the sea-fastened deck up to the final mating, retrieval of the cargo barge or vessel and welding of the deck onto the jacket,
- the demobilisation of the cargo barge or vessel

CONTRACTOR shall make immediately available at offshore site all the necessary additional spare parts (jacks, HPU, oil, etc) to complete the job in a satisfactory and safe manner,

CONTRACTOR shall provide the necessary equipment to control and monitor the motions and tensions/reactions during the float-over. The data acquisition and calibration analysis shall be provided to COMPANY not later than three months after the operation.

CONTRACTOR shall review and endorse the design of the jacket, piles and deck during the float-over. Due attention and analysis are required with respect to the coupled model piles + jacket + deck + cargo barge or vessel at the different steps. The yaw effect on the jacket with vertical piles shall be fully analysed.

CONTRACTOR shall supervise to his satisfaction the final cutting on the piles.

CONTRACTOR shall perform a dimensional control of the top of the piles to confirm his endorsement of this interface.

The information and documents required by this specification shall be communicated to COMPANY in good time depending on the complexity of the method.

For the float-over operation, the following shall be provided by CONTRACTOR:

- The manpower
- The material
- The equipment
- Consumables, etc.

required for the float-over operation, in particular winches, jacks, idle pulleys, guides and bumpers, ballasting pumps, moorings, anchors, etc.

Float-over operation shall be avoided during night. Only authorized persons involved in the float-over operation are allowed on the cargo barge or vessel where life vests are mandatory.

7.4.3.4 Float-over procedure

The float-over procedure from the arrival of the cargo barge or vessel at offshore site up to the retrieval and demobilisation of the cargo barge or vessel shall be established by CONTRACTOR and submitted to the Marine Surveyor and COMPANY for approval.

This procedure shall define (but not limited to) the following:

- the selected float-over method, float-over scenario step by step and relevant monitoring: jacking system, ballast system, motions, mooring, etc.
- the environmental criteria, measurements and monitoring: tide, wave, current, wind, etc.
- the deck structure to be loaded

- the loads applied to the jacket & piles, deck structure, sub-structure, cargo barge or vessel during the float-over
- the cargo barge or vessel ballasting/de-ballasting procedures, calculations, draft /trim /heel surveys and monitoring
- the jacking system, stroke, capacity and monitoring
- the barge (strength, stability, etc.)
- the float-over equipment, material, additional structures and accessories, utility requirements (electrical, cooling water, Hydraulic Power Units, etc), control room, general arrangement, hydraulic pressures & strokes monitoring, the back-up devices, etc
- the manpower, consumables, etc.
- the emergency procedure
- the float-over limitations: wave, current, wind, motions, etc.
- the float-over timing including margin
- the supply of COMPANY office and CONTRACTOR office close to the float-over control room with the necessary furniture, telephone, electrical power, HVAC and documentation. Permanent display in real time of the monitored critical data (Datawell buoy, cargo barge or vessel motions, jacks pressure/strokes, loads, tensions, moorings, drafts, etc) shall be made available to COMPANY and MWS on computer screens in the COMPANY office. This duplication shall be part of the necessary equipment redundancy for such a critical operation.

Important note: The float-over procedure shall include the necessary calculation notes to document all above items, their strength, the clearances, the specific tolerances etc.

The back-up capacity for accidental conditions will be able either to complete the operation or to be able to retrieve the deck from inside of the jacket.

7.4.3.5 Float-over preparation

The preparation of the installation shall be part of the installation. It shall clearly describe all the work/tests to be carried out to ensure

7.4.3.6 Equipment Tests

The ship equipment shall be tested before departure from the construction yard.

7.4.3.7 Preparation of the Jacket

The jacket leg fenders and the cones shall be installed or controlled.

The hawsers shall be preinstalled with proper lashing to allow an easy connection. It shall be checked that they have no interference with other equipment.

The access ways to all the legs shall be installed.

Dimensional control of the jacket shall be available prior operation.

The cones at the top of jacket piles shall be greased before operation.

7.4.3.8 Environmental Data Acquisition System Installation

The datawell buoy shall be installed on site.

The tide meter and the current meter shall be installed on a close platform or the jacket.

Wind measurement shall be available from a close platform or from the support barge.

During the calibration period, the meteorologist shall be on the support barge and he shall be transferred on the ship with his equipment as soon as she arrives.

7.4.3.9 Anchors Legs Installation

The 4 anchor legs on site will be preinstalled and will be proof loaded at 50 metric tons.

7.4.3.10 Waiting Area

When the barge arrives in Nigeria, it shall go to a predefined waiting area a few miles from the site to perform the preparatory works.

7.4.3.11 Sea-Fastening Removal

The main sea fastening shall be removed either on the waiting area, or during the last part of the route to be approved by the MWS and COMPANY.

A temporary sea fastening shall be ensured by the substructures, which shall be sufficient to withstand the site conditions.

7.4.3.12 Preparation / Test of the Jacking System

Voyage protections shall be removed and the installation shall be returned to its operational configuration. Equipment shall be reconnected, checked and started.

Functional tests shall be carried out, including deck elevation and return on transport support.

7.4.3.13 Test of Equipment

Functional tests of the installation equipment shall be performed including:

- ship motion monitoring system,
- ballast / ballast control system,
- line tension monitoring system,
- mooring winches,
- video cameras.

7.4.3.14 Ballasting procedure

The procedure shall be established during detail studies, so that at all steps of the installation operation, the control of the barge draft, trim and list, the control of the loads transferred, and the control of the required clearances are ensured.

The selection of tanks to be used at each step shall be done considering the following criteria:

- the stress induced in the barge and deck shall stay to an acceptable level,
- trim and list control before beginning of deck weight transfer and after 100% deck weight transfer,

- operational criteria such as flow rates in each tank, hoses connections facilities, etc...
- possibility of emergency deballasting at a sufficient flow rate especially in the critical phase just before mating,
- ballast operation shall be done in 3 hours maximum.

7.4.3.15 Float-over studies

CONTRACTOR shall perform the float-over studies to analyse the behaviour of the cargo barge or vessel carrying the deck and the jacket during the different phases of the float-over operation step by step.

If the installation method requires the deck to be jacked-up prior to the entrance within the jacket leg, stability of the vessel in this configuration shall be checked.

Due attention and analysis are required with respect to the coupled model piles + jacket + deck + cargo barge or vessel at the different steps. The yaw effect on the jacket with vertical piles shall be fully analysed.

3D diffraction/radiation calculation shall be performed with recognised software to define hydrodynamic data for all the vessel drafts corresponding to the installation steps to be analysed. Calculation of the full quadratic transfer function of the wave drift force is required as Newman approximation is not applicable.

Dynamic response of vessel shall be performed at all critical points where clearances need to be defined. Frequency domain approach is accepted by COMPANY to derive heave, roll and pitch motion when no contact is arising. Horizontal motions calculation requires time domain approach including low & wave frequency motions (based upon full QTF formulation). Potential changes in wind and current direction/velocity shall be accounted for in the definition of the motion envelop. Particular attention shall be paid to the dynamic behaviour of the mooring lines. When significant, non-linearity and frequency dependence of the mooring line stiffness shall be fully accounted for in the model.

During the float-over operation, when contacts/impacts occur between "bodies" time domain approach of a fully coupled model shall be implemented to capture all the non-linearity behaviour of the system. The coupled analysis shall account for all non-linearities coming from:

- Boundary conditions such as soil conditions
- Any system interfacing between the different "bodies" (mooring lines, fenders, shock absorbers, positioning system ...)
- The contact/impact loads.

The non-linear time domain coupled analysis shall determine the movements and the resulting loads applied to the deck, fenders and jacket from the entrance of the cargo barge/vessel within the jacket up to the final mating and removal of the cargo barge/vessel.

3D structural analysis shall determine and check the stresses imposed to the structures of the cargo barge or vessel, deck, fenders system and jacket/piles by the movements and loads resulting from paragraph above.

The computer programs shall be documented and the following shall be detailed:

- Description of the different axis systems
- Description of input data, including default values, units, and relevant axis systems

- Description of outputs, including units and relevant axis systems.

The models used for the cargo barge or vessel, substructures, deck, jacket and piles shall be documented in detail in the calculation note which shall include at least:

- Geometrical descriptions
- Mass and inertia descriptions
- Hydrodynamic coefficients descriptions
- Damping factors
- Description of boundary conditions
- The water depth
- The time step and the number of steps studied

Accidental case shall be analysed assuming one mooring line failure during vessel entrance under the pre-defined weather limit conditions by CONTRACTOR for this phase of the operation. Induced load on the jacket and fenders shall be fully accounted for.

Stability calculation assuming one compartment flooded during vessel entrance shall be carried out to demonstrate that the reduction of clearance in this situation still allows the retrieval of the installation vessel.

The results shall be documented in detail in the calculation note for each step.

Model tests in basin shall be performed for un-experienced float-over operation with long swell representative of Gulf of Guinea conditions.

7.4.3.16 Allowable conditions for installation

The motions of the cargo barge/vessel are very sensitive to the wave period, the wave heading and the wave height. The weather limit conditions shall be defined taking into account these 3 parameters.

The limit weather conditions (wave, wind and current) with their probability of exceedence shall be identified by CONTRACTOR for the following phases of the installation operation:

- Stand-by on waiting area with reduced sea fastening
- Preparatory work on waiting area
- Approach and mooring on site
- Winch line connection
- Entrance within jacket and mating condition

The motions at the bottom of the deck legs shall be the governing parameter to decide whether the conditions are acceptable to start entering into the jacket legs. The motions at bottom of the legs shall be derived in real time during the operation. Table and curves defining the maximum allowable motions shall be established and included in the installation procedure.

7.4.3.17 Contingency / Emergency procedure

A risk analysis shall be performed before issue of the contingency/emergency procedure, in order to highlight the most critical events.

The contingency/emergency procedure shall deal with all the steps of the operation and shall particularly address the tide constraints and compensation methods.

Criteria for stopping or aborting the each stage of operation shall be defined and submitted to the Company for approval. Contingency procedures and schedules shall be developed for stopping or aborting the docking and mating operations. The “No return” critical point for the float-over installation should be identified and accepted by the Company. This shall include making each phase of the installation operation reversible.

7.4.4 Installation of other frames and structures

Other frames such as modules, flares, catwalks and masts shall be hoisted and installed as stipulated in the Particular Specification.

7.5 Final steps

7.5.1 Temporary navigation aids

The CONTRACTOR shall be responsible for supplying and installing all temporary aids required for navigation during the complete duration of installation.

The CONTRACTOR shall respect:

- Local regulations applicable to the site or country involved
- Or, if such regulations are insufficient at COMPANY's discretion, the International Association of Lighthouse Authorities (IALA) regulations, in particular § 44. Navigation aids may either be acoustical and/or optical and/or radio-electrical; they shall be installed by the CONTRACTOR at the locations provided:
 - The CONTRACTOR shall ensure that they operate correctly by means of regular checks.
 - He shall replace at his own cost unless otherwise specified in the Contract, any navigation aids, lost during a storm or for any other reason, as soon as possible.

7.5.2 Protection against corrosion

Painted or galvanized surfaces damaged during handling, welding, etc., shall be repaired by the CONTRACTOR as stipulated in **GS COR 350**, in particular in § 9.4, and particular specification.

7.5.3 Site and structure cleaning

Throughout the duration of works, the CONTRACTOR shall keep the site clean. The CONTRACTOR shall recover any debris or equipment dropped into the water to the satisfaction of the COMPANY'S representative.

After completion of structure installation, the CONTRACTOR shall clear the jacket, deck(s), platform(s), catwalks(s) and any other spaces of all debris, auxiliary equipment, surplus materials, equipment and temporary structures, to the satisfaction of the COMPANY's representative.

7.6 Tolerances

The tolerances shall satisfy and strictly conform to the drawings and the Particular Specification.

The CONTRACTOR shall, throughout the various installation phases, carry out any inspections and/or tests required to ensure that the conditions required by the specifications are fully satisfied.

Measurements shall be taken as often as necessary to ensure that the results are accurate.

7.6.1 Measuring equipment

The CONTRACTOR shall:

- Supply all measuring instruments required to ensure that the various parts of the structure (jacket, piles, deck(s), etc.) are correctly and accurately installed.

The measurement instruments shall be accurate and their tolerances shall be compatible with the tolerances imposed for installation.

- Supply all platforms, bearers and temporary marks required to use the equipment described below.
- Use experienced personnel capable of using the measurement instruments effectively.

A non-exhaustive list of the equipment required is given below:

- A bathymeter for surveying the seabed
- An optical system, working from fixed marks, or an electronic locator for planer surveys
- A micro-wave system to accurately measure distances
- Optical (or laser) equipment to measure alignments and levels
- A stilling tube and tide recorder.

The CONTRACTOR shall keep all recordings concerning all the measurements taken and shall supply them to the COMPANY with the project termination file.

7.6.2 Piles

Piles shall be driven to the planned penetration.

The pile-head elevation shall equal to the theoretical elevation to within ± 5 cm. The slope of the deck (if any) shall be taken into account when defining this elevation.

All pile-heads shall be levelled to within ± 6 mm.

7.6.3 Jacket

7.6.3.1 General

The CONTRACTOR shall check that the jacket installation tolerances are met throughout the installation operation:

- During positioning
- Just before beginning pile driving
- During driving operations
- Upon completion of pile installation
- After making the welded joint between the piles and the jacket.

Unless otherwise indicated in the particular specification, elevations shall be referred to the Chart Datum.

7.6.3.2 Isolated jacket or the first jacket in a complex

Unless otherwise indicated, the CONTRACTOR shall position the centre of the jacket to within ± 7.5 m of the marked position.

The main centrelines shall be orientated to within $\pm 1^\circ$ of the theoretical direction.

The elevation of the central point shall be to within ± 30 cm of the theoretical elevation and all corners shall be level to within ± 7.5 cm of the final elevation of the central point.

7.6.3.3 Jackets connected to existing installations

Compared to the tolerances stipulated in the paragraph above, the first positioning tolerance imposed on the CONTRACTOR is, obviously, tighter:

- The Centre of the jacket shall lie within a circle of radius one metre, centered on the theoretical coordinates given on the drawings.

The other two tolerances remain identical to those indicated above with respect to their final positioning:

- Orientation: ± 1 degree
- Elevation: ± 30 cm and ± 7.5 cm

These values shall be confirmed in the Particular Specification.

7.6.4 Deck(s)

The CONTRACTOR shall respect the following tolerances for each deck (or section of deck) installed:

- Angle between the main deck external beams and the jacket faces: less than 0.5 degrees
- Elevation of the deck flooring at the centre of the jacket: to within ± 3 cm of the theoretical elevation
- The four corners of the deck shall be levelled to within ± 12 mm of the actual elevation of the deck flooring at the center of the jacket.

7.6.5 Boat landing(s)

The elevation of the boat landing(s) shall be checked at low tide. The elevation must be to within ± 30 cm (1 foot) of the theoretical elevation.

8. Documents

8.1 Documents to be supplied by the COMPANY to the CONTRACTOR

The COMPANY shall supply the CONTRACTOR with the Particular Specification, which, in particular, shall stipulate:

- The share-out of responsibilities between COMPANY, CONTRACTORS, Certification Authorities, Marine Surveyor and Warranty Insurance Surveyor (see § 3.2)
- The names and responsibilities attributed to the Certification Authorities

- Weighing operations to be carried out before loading
- The values of abrupt differences in the level of bearers during loading if design is not performed by CONTRACTOR
- The roll, pitch and heave to be used to calculate the sea-fastening system (if they differ from those indicated in § 5.4)
- The site characteristics (water depth, soil properties, and (if applicable) the pile driving curves of any surrounding platforms)
- Information concerning weather conditions
- The number of test pieces to be provided for grouting (see § 7.3)
- Any conditions applicable to the use of conductor pipes or skirt piles (§ 7.3)
- Certifying Authority for Materials and accessories for lifting (see § 7.2.1 and 7.4.1)
- Requirements concerning the installation of the deck and other frames (§ 7.4.2 to 7.4.4)
- Tolerances, if they differ from those given in § 7.6.

In addition, COMPANY shall supply the CONTRACTOR with the permits required to access to and use the site selected for the installation of the structure.

8.2 Documents to be submitted by the CONTRACTOR to the COMPANY

The division of documents to be submitted to COMPANY shall be clearly defined in the Particular Specification.

8.2.1 With the proposal

The technical documents to be submitted shall include, in particular:

- The principles of methods used for loading and barge grillage/sea fastening
- A description of the barges and tugs to be used for transport and installation
- The principles of methods selected for the jacket, pile, deck and structure installation, including a list of the main items of equipment with their capacity (cranes, jacking system, hammers, drilling rigs, etc.)
- A general time schedule which shall take account, in particular, of the meteorological conditions which could be encountered on the site and proposed methods of progress measurement
- A personnel organization chart.

8.2.2 After award of the contract

8.2.2.1 During the preliminary design and preparation phase

- The calculation notes and preliminary drawings
- The various issues of progress planning schedules
- Weighing procedure
- Approval of method to be used for pile installation

- The design documentation for the lifting beam and hoisting lugs

8.2.2.2 Twenty weeks before loading (see § 4)

- Calculation notes for the weights and centre gravity of the structures to be installed
- The detailed loading procedure, including in particular loading sketch
- Calculation notes concerning the behaviour of the structure under the effect of abrupt out-of-levels in the bearers
- The time schedule and organization chart applicable to the personnel responsible for the operation.

8.2.2.3 Twenty weeks before sea-fastening and barge grillage operations (see § 5)

- The calculation notes, clearly differentiating the three parts detailed in § 5
- The general arrangement drawings and the detail drawings concerning sea-fastening and barge grillage
- The technical documents concerning welding
- The time schedule and the organization chart applicable to the personnel responsible for the operation.

8.2.2.4 Twelve weeks before transportation

- A detailed list and certificates of sea-worthiness of the marine machinery to be used, including their specifications and technical characteristics, (the COMPANY's representative may choose to visit and inspect this machinery)
- Details of the sea route selected and any possibilities of shelter
- The time schedule and organization chart for the personnel responsible for the operation.

8.2.2.5 Four months before installation (see § 7)

The procedure detailed in § 7.1.1, including the following sections:

- Survey and marking operations
- Anchor patterns
- Hoisting barge or jack-up
- Cargo barge
- Jacket installation
- Pile and CP installation
- Pile and CP driving monitoring
- Jetting/driving procedure
- Welding
- Installation of the deck and other frames
- Checking of tolerances

- Painting and repair procedure
- Time schedule
- Slings, shackles, spreader bar/frame certificates
- Emergency procedure.

The personnel organization chart, detailing, in particular, any sub-contracting considered for diving, survey, positioning tolerance inspection and weld inspection and emergency.

If applicable, the test report for the jacking system, lifting beams, slings and accessories.

8.2.3 Before load-out

Load-out certificate (to be issued by Marine Surveyor).

8.2.4 Before sail away

Sail away certificate (to be issued by Marine Surveyor).

8.2.5 During installation

The CONTRACTOR shall maintain a chronological log of all major events occurring during operations. The documents presented to the COMPANY's representative shall include daily reports, weekly or monthly progress reports, material sheets, inspection reports or test certificates and all routine documents.

The CONTRACTOR shall also provide the COMPANY's representative with:

- The documents listed in Specification GS STR 431
- The values measured to ensure that the installation tolerances have been met
- The weld inspection information.

In addition, the CONTRACTOR shall give the COMPANY's representative prior notice of any major operations which he intends to undertake, and of any risk of an incident or accident which could occur during structure installation.

Finally, the CONTRACTOR shall provide the COMPANY with written notice of final completion of installation.

8.2.6 After completion of installation

The CONTRACTOR shall supply the COMPANY, within one month of completion of work, with a complete file (in five copies plus one reproducible), comprising:

- As built drawings
- The complete installation report, which shall contain a clean and final version of all documents listed in § 8.2.5.

Appendix 1 Check list of information required for approval of load-out

1 Module

1.1 Structural analysis report for module, including:

- Structural drawings including any additional load-out steelwork
- Description of finite element program used
- Structural model
- Description of support conditions
- Load cases including derivation of weights and contingencies
- Unity checks
- Justification of overstressed members
- Detailed checks of module support points, pad eyes, winch connection points and intermediate structures
- Proposals for reinforcements if required.

1.2 Weight report for module (results of weighing operation if available).

2 Site

2.1 Site plan, showing load-out quay, position of module, position of all mooring bollards and winches and any reinforced areas with allowable bearing capacities.

2.2 Section through quay wall.

2.3 Drawing showing heights above datum of quay, quay approaches, module support points, barge, link beam, pad (if applicable) and water levels.

2.4 Calculation of maximum allowable loadings on quay, quay approaches, wall and foundations.

2.5 Specification for all mooring bollards and other attachment points proposed.

2.6 Bathymetric survey report of area adjacent to the quay and passage to deep water, related to same datum as item 2.3.

2.7 Bathymetric survey of pad, for grounded load-outs.

2.8 Structural drawings of skid ways and link beams, with calculation of structural capacity and supporting calculations.

2.9 Skid-shoes: structural drawings and relevant calculations of skid shoes and any additional structure between the module and skid ways.

2.10 Tide survey.



3 Barge

3.1 General arrangement and compartment drawings.

3.2 Hydrostatic tables and tank tables.

3.3 Details of class.

3.4 Calculations of allowable deck loadings and skid way loadings if applicable.

3.5 Specification of all mooring bollards.

3.6 Details and calculation of any additional steelwork such as grillages or winch attachments.

3.7 Details of barge pumping system.

4 Trailers

4.1 Trailer specification and configuration.

4.2 Details of any additional supporting steelwork.

4.3 Allowable and actual axle loadings.

4.4 Allowable and actual spine bending moments and shear forces.

4.5 Schematic of hydraulic interconnections.

4.6 Specification of tractors if used.

5 Pumps

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

5.2 Pipe schematic, and details of manifolds and valves where applicable.

5.3 Pump performance curves.

6 Jacking/winching

6.1 Jack/winch specification.

6.2 Layout of pull-on system.

6.3 Layout of pull-back system.

6.4 Details of power sources and back-up equipment.

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

7 Ballast calculations

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

7.2 Ballast calculations for each stage showing:

- Time
- Tidal level
- Module position
- Weight on quay, link beam and barge

- Ballast distribution
- Barge draft, trim and heel
- Pumps in use, and pump rates required.

7.3 Stages to be considered should include as a minimum:

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

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

8 Lifted load-outs

8.1 Slings arrangement.

8.2 Crane load-radius curve.

8.3 Copy of crane certification.

8.4 Copy of certificates of slings and shackles and other equipment.

8.5 For mobile cranes, position of crane at pick-up and set down and ground bearing pressures.

8.6 Non-destructive testing report of lifting attachments and connection into module.

8.7 Mooring arrangements and thrusters specification for floating cranes.

9 Moorings

9.1 Limiting weather conditions for load-out.

9.2 Mooring arrangements for load-out operation and post-load-out condition.

9.3 Calculations showing environmental loads for limiting weather condition for load-out, and for 10-year storm for post-load-out moorings.

9.4 Specification and certificates of all wires, ropes, shackles and chains.

9.5 Details of findering.

10 Tugs

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

11 Management

11.1 Organigram showing management structure and responsibilities.

11.2 Location of key personnel.

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

11.4 Times of shift changes, if applicable.

11.5 Communications.

11.6 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
- Module movements
- Load-out operation
- Trailer removal
- Sea-fastening
- Remooring
- Decision points.

11.7 Methods of monitoring barge level and trim, and ballast quantities.

11.8 If a computerised ballast control system is to be used, a description of the program should be supplied.

11.9 Time and place for progress and decision meetings.**12 Contingencies****12.1** Contingency plans shall be presented for all eventualities, including:

- Pump failure
- Main supply failure
- Jack/winch failure
- Trailer power pack failure
- Trailer hydraulics failure
- Trailer tyre failure
- Tractor failure
- Failure of any computerised control or monitoring system
- Mooring system failure
- Structural failure
- Deteriorating weather.