OIL INDIA LIMITED
KG BASIN PROJECT
KAKINADA

AMENDMENT No. 3 Dated 16.02.2024

Tender No. CEG5287P24 for engaging EPCI Contractor on LSTK basis for Well Head platforms with minimum facilities, Subsea and Onshore pipelines including monitor & control system for development of OIL's shallow water offshore block KG/OSDSF/GSKW/2018 and Onshore part in ONGCL's Block at Odalarevu & Kesanapalli area for a period of about 2 years.

1.0 Pursuant to the Pre-bid Conference held for Tender No. CEG5287P24 on 17.01.2024, this amendment is issued to notify the following to the participating bidders:

A. Structural design basis Offshore WHP (East) Doc: 5153-DCE1-ST-L-2001-Rev D1 is made available to bidders through this amendment (enclosed herewith) as the west structural document (in place of east structural document) was inadvertently uploaded in the original tender document.

B. Minutes of Pre-bid Meeting and OIL's response to Pre-bid queries of bidders are uploaded in OIL's e-portal under "Technical Attachments" Tab.

2.0 All other terms and conditions of the Tender remain unchanged.

Oil India Limited
KG Basin Project

Structural Design Basis-Offshore WHP (East)

Doc No: 5153-DCE1-ST-L-2001

D1	01.07.2023	AR	Re Issued for Bid	SN	ADS	--
C1	18.01.2023	AG	Issued for Bid	SN	ADS	--
B1	30.04.2022	AG	Issued for Client Review / Comments	SN	ADS	--
A1	25.03.2022	AG	Issued for DIC/IDR	SN	ADS	--
Rev	**Date**	**Pre'd**	**Description**	**Chk'd**	**App'd**	**Client**

Table of Content

1.0 INTRODUCTION

1.1 Scope

The scope of this document is to describe the Structural Design Basis for proposed offshore East wellhead platform.

Establish key design basis parameters which will be input for arriving Pre-FEED definition which will be detailed further at Detailed Engineering stage by LSTK Contractor.

The requirements of this document are to be considered as minimum requirements and LSTK CONTRACTOR / VENDOR may submit to the COMPANY, for agreement, any possible solutions, with supporting calculation notes that could give technical and / or economic improvement.

Any omission in this requirement shall not relieve the LSTK / CONTRACTOR of his responsibility to deliver the equipment along with other associated items, which are complete, of proven design, and conform to the Performance Requirements.

1.2 Definitions of Terms

The CLIENT /COMPANY / OWNER where used in this specification shall mean the ultimate user / owner of the plant and facilities, Oil India Limited, Kakinada Asser (OIL)

The LSTK CONTRACTOR / CONTRACTOR / PURCHASER where used in this specification shall mean the party, who undertake LSTK / EPC contract for the above project.

The VENDOR / SUPPLIER where used in this specification shall mean the party, who manufactures or supplies the equipment and services specified.

The INSPECTOR / TPIA where used in this specification shall mean the PURCHASER / COMPANY or their authorized Third Party Inspection Agency for carrying out the inspection.

The PMC / ENGINEER where used in this specification shall mean the party, who perform Design Engineering Consultancy and Project Management for the COMPANY, (PETRO6E&C).

1.3 Abbreviations

Unless otherwise specified following notations / abbreviations shall be applicable to document

API	:	American Petroleum Institute
BBL	:	British Oil Barrels (42 -US gallons)
BCF	:	Billion Cubic Feet
BOPD	:	Barrels of Oil Per Day
ESD	:	Emergency Shutdown
EUR	:	Estimated Ultimate Recovery
MMSCFD	:	Million Standard Cubic Feet per Day
MMSCMD	:	Million Standard Cubic Meter per Day
MMBBL	:	Million British Barrels
OIL	:	Oil India Limited
OISD	:	Oil Industries Safety Directorate
ONGC	:	Oil and Gas Corporation Limited
PFD	:	Process Flow Diagram
P&ID	:	Piping and Instrumentation Diagram
PMC	:	Project Management Consultant
PNGRB	:	Petroleum and Natural Gas Regulatory Board
PPM	:	Parts Per Million
SCFD	:	Standard Cubic Feet per Day
SCMD	:	Standard Cubic Meter per Day
UFD	:	Utility Flow Diagram
W/C	:	Water Cut %

2.0 PROJECT OVERVIEW

2.1 Field Location

The Block KG/OSDSF/GSKW/2018 can be approached by air, water and surface transport as given below:

Nearest Airports:	Visakhpatnam	180 Kms
	Rajahmundry	70 Kms
Nearest Sea Port:	Kakinada	15 Kms
Nearest Railway Junction:	Samalkot	20 Kms
	Kakinada	20 Kms
National Highway:	NH-5	

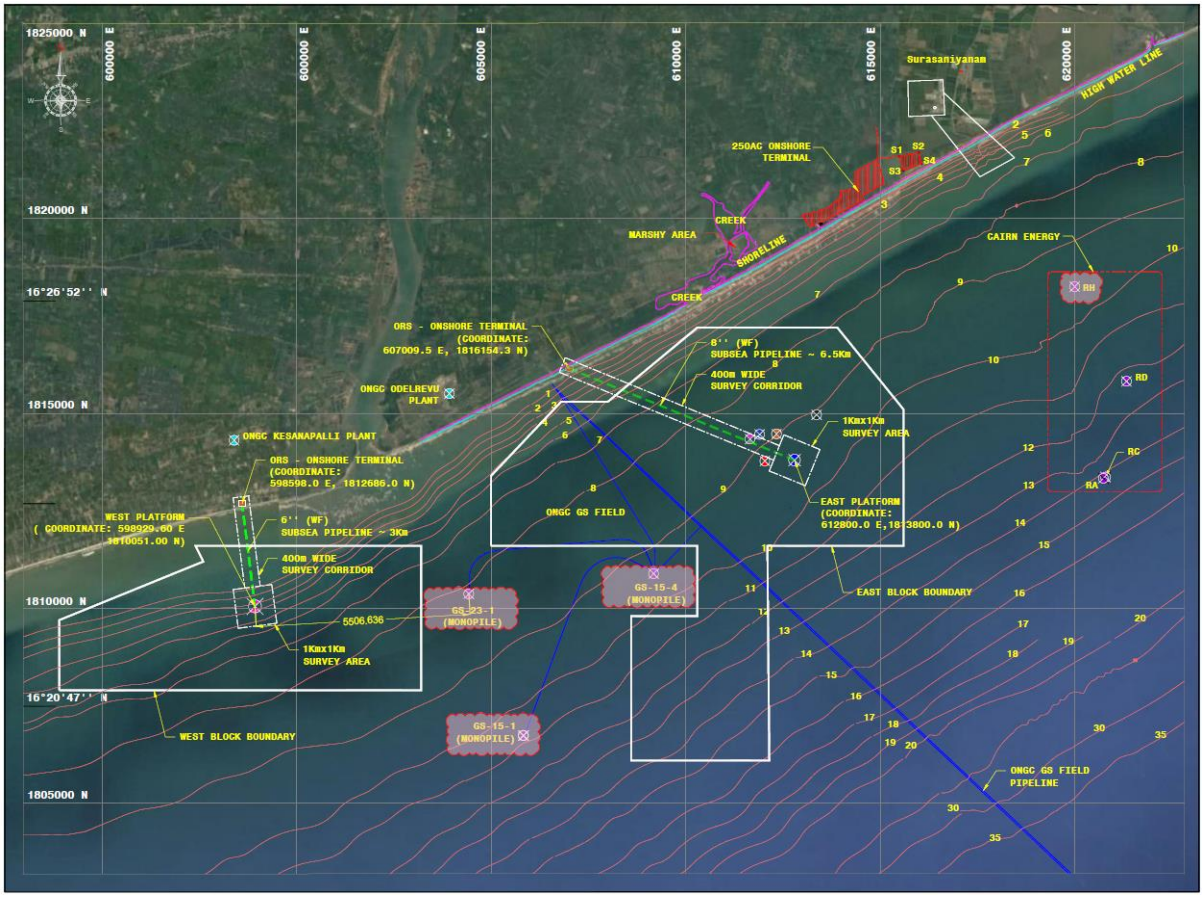

Figure 1.2 Location of DSF-II Field

The east and west block are surrounded by platforms operated by ONGC and Cairn (Vedanta) as shown in figure 1.2. Platforms GS-15-1, GS-154 and GS-23-1 are located between the east and west block while Cairn Platforms RC, RD and RH are located east of east block.

2.2 Field Development Plan

The field development involves offshore drilling, transportation of production fluid via subsea pipeline, oil processing / stabilization, gas conditioning, evacuation of oil and gas for sales.

The overall Field Development Plan includes development of one wellhead platform (DCE1), onshore receiving and treatment facilities (GEOT) and subsea pipeline from DCE1 to GEOT on East Block. Similarly, one wellhead platform (DCW2), onshore receiving and treatment facilities (GWOT) and subsea pipeline from DCW2 to GWOT on West Block.

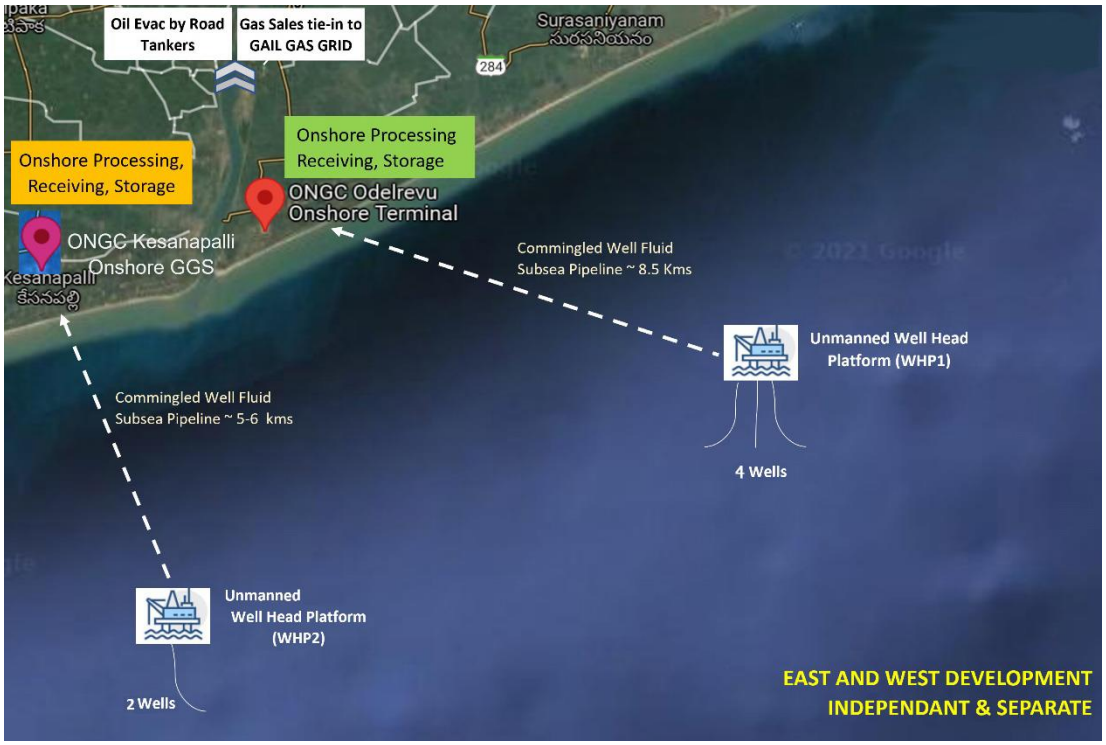

Figure 1.3 East & West Block platforms and pipelines

3.0 CODES AND STANDARDS, REFERENCES

3.1 Reference Project Documents / Drawings

The latest revision of the following project specification / documents shall form integral part of the design basis.

Table 3.1 Reference documents / Drawings

Document / Drawing No	Document / Drawing Name
5153-DCE1-PL-L-2001	Pipeline & Riser Design Basis – East platform
5153-DCE1-PR-D-2002.01 to 2002.04	Process Flow Diagrams / Utility Flow Diagrams
5153-DCE1-PR-D-2000.01 to 2014.01	Piping & Instrumentation Diagrams (P&IDs)
JMGP22-219013/Vol2 – Metocean / FR/R0 [00]	Metocean studies report - Geophysical and Geotechnical Surveys at Offshore Block KG/OSDSF/GSKW/2018
JMGP22-219013/Vol2 – Metocean / FR/R1 [01]	Metocean studies report - Geophysical and Geotechnical Surveys at Offshore Block KG/OSDSF/GSKW/2018
JMGP22-219013/Vol1-Metocean/FR/R2	Volume 1 - Metocean studies report - Geophysical and Geotechnical Surveys at Offshore Block KG/OSDSF/GSKW/2018

JMGP22-219013/Vol2-Ops/FR/R2	Volume 2 - Operations report - Geophysical and Geotechnical Surveys at Offshore Block KG/OSDSF/GSKW/2018
JMGP22-219013/Vol3-Geophysical Results/FR/R1	Volume 3 – Geophysical results - Geophysical and Geotechnical Surveys at Offshore Block KG/OSDSF/GSKW/2018
Fugro Document No. 226705 – OIL-RPT - 01	Volume 4 – Geotechnical report - Geophysical and Geotechnical Surveys at Offshore Block KG/OSDSF/GSKW/2018
Fugro Document No. 226705 – OIL-RPT - 02	Volume 4 – Geotechnical report - Geophysical and Geotechnical Surveys at Offshore Block KG/OSDSF/GSKW/2018
Report No: FR04	Proposed east platform location
Bathymetry Drawings	
1076 – 0R10 (Sheet 1 of 5)	Proposed pipeline east platform to LFP
1076 – 0R20 (Sheet 2 of 5)	Proposed pipeline east platform to LFP
1078 - 0R10 (Sheet 4 of 5)	Proposed east platform

3.2 International Codes and Standards

The design, materials, fabrication, inspection and testing of platform structures shall be in accordance with this document and the latest editions (including addenda / errata) of the codes and standards as listed below.

Table 3.2 Codes & Standards

Code	Description
AISC Codes	
AISC	American Institute of Steel Construction - Manual of Steel Construction
American Society of Mechanical Engineers (ASME)	
ASME B31.8	Gas Transmission and Distribution Piping Systems.
American Petroleum Institute (API)	
API RP 2A - WSD	Recommended practice for planning, designing, construction of fixed offshore platforms.
Det Norske Veritas (DNV)	
DNV RPB-401	Cathodic Protection System
NDI-0013	Guidelines for Load-out

NDI-021	Guidelines for Approvability of Towing
NDI-0027	Guidelines for Lifting operations By Floating crane vessels
NDI-0030	General Guidelines for marine Transportations
Swedish Standards	
SIS 05-5900	Swedish Standards Institution for Surface Preparation.
Indian Standards	
IS - 875 (Part - 3)	Codes of practice for design loads (other than earthquake) for buildings and structures.
IS – 1893	Criteria for earthquake resistance design of structures
EN10204	Materials Testing Certificates
OMR	Oil Mines Regulations
OISD	Oil Industries Safety Directorate regulations
DGMS	Directorate General of Mines Safety
IER	Indian Electricity Rules
CPCB	Central Pollution Control Board of India

National Laws and regulations together with any local by-laws for the country or state wherever the Equipment / package are to be used must be complied with by the VENDOR / FABRICATOR / LSTK CONTRACTOR.

3.3 Units

The metric system of units will be used for all calculations, drawings and in all project documentation.

4.0 DESIGN DATA

4.1 Design Life

The design service life of east field platform shall be 15years. The design fatigue life shall be calculated as per API RP 2A based on Table 5.2.

4.2 Design Conditions

The design of platform structure shall be carried out as per 22nd Edition of API RP 2A. The following design conditions shall be adopted.

Operating Condition : 1 year Environmental Parameters
Extreme Condition : 100 Year Environmental Parameters.

4.3 Platform information

The platform information adopted has been derived based on facility requirement, geotechnical information, and met-ocean parameters for east field. The following configuration is to be adopted by LSTK Contractor.

a) Tripod jacket structure supported on 3 main piles.
b) Topsides consisting of cellar deck and Main deck cum Helideck.

4.4 Water Depth

The water depth at the proposed location of East platform is about 10.2m with respect to chart datum. **The water depth is taken from Volume 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01].**

4.5 Mudline Soil Condition

Based on the geotechnical data, **Volume 4 – Geotechnical and geohazard assessment report (Doc No: FGTL/BCPL/ED/20-226705/RPT*]***, clay soil condition is located at the proposed location.

4.6 Seabed Slope

Seabed slope shall be evaluated based on the bathymetry chart made available with the tender.

4.7 Astronomical Tide Level

The astronomical tide level data has been extracted from the **Volume 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01].** and the tide level data is summarized in table 4.1.

Table 4.1 Astronomical tide level data

Datum	Tide level (m) with respect to CD
Mean High Water Springs (MHWS)	+1.30
Mean Higher Water Neaps (MHWN)	+1.00
Mean Sea Level (MSL)	+0.80
Mean Low Water Neaps (MLWN)	+0.50
Mean Low Water Springs (MLWS)	+0.20

4.8 Environmental Data

4.8.1 Wind data

The wind speed data has been extracted from the **Volume 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01].** and the wind data are summarized in table 4.2 and 4.3 for operating (1 year return period) and extreme (100-year return period) respectively. Wind shall be considered Omni-directional.

Table 4.2 Operating wind speed (1 year return period)

Design condition	Wind speed (m/sec)	Remarks
Operating	10.7	1 hour average
	12.5	1 min. average
	15.5	3 sec gust

Table 4.3 Extreme wind speed (100 year return period)

Design condition	Wind speed (m/sec)	Remarks
Extreme	30.6	1 hour average
	35.8	1 min. average
	44.4	3 sec gust

The design wind speed for substructure and superstructure Inplace analysis shall be as per Table 4.4.

Table 4.4 Design wind speed

S.No	Description	Design wind forces
1	Jacket Inplace analysis	1Hr. Average
2	Deck Inplace analysis	1Min. Average
3	Building/Module frame analysis	5 sec. gust
4	Cantilever Structures, towers, vents, flare booms, bridges of length less than 50 M	3 Sec. gust
5	Exterior Wall panels of buildings, barrier walls, including their stiffeners	3 Sec. gust

4.8.2 Wave Data

The wave data has been extracted from the **Volume 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01]** and the wave data is summarized in table 4.5.

Table 4.5 Wave data

Design condition	Wave Height (H_{max}) (m)	Period (Sec)	Remarks
Operating	2.9	9.0	1year return period
Extreme	10.8	22.0	100year return period

4.8.3 Current Parameters

The current data has been extracted from the **Volume 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01]** and the current data for operating and extreme condition is summarized in table 4.6.

Table 4.6 Current parameters

Design condition	Current (m/sec)	Remarks
Operating	0.23	1 year return period
Extreme	1.25	100 year return period

It is to be noted that the current shall be considered omni-directional since it is due to river discharge and tidal condition.

4.8.4 Storm Surge

The storm surge has been extracted from the **Volume 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01]** and the storm surge for operating and extreme condition is summarized in table 4.7.

Table 4.7 Storm Surge

Design condition	Storm surge (m)	Remarks
Operating	0.04	
Storm	1.03	

4.8.5 Fatigue Environmental Data

The fatigue environmental data has been extracted from the **Volume 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01]- Appendix A.**

4.8.6 Installation Environmental Data

The installation wave shall be evaluated ***based on Volume* 1 – Metocean studies report (Doc No: JMGP22 – 219013 / Vol1 – Metocean/ FR/R2 [01].**

4.9 Splash Zone and Corrosion Zones

The splash zone range of EL (-) 2.00m and (+) 6.00m levels shall be used in all in-service analysis. Accordingly, the corrosion allowance shall be provided for jacket members (i.e, legs & elevation braces) present in the splash zone area (ref. section 5.13.1)

4.10 Marine Growth

The marine growth profile for submerged & splash zone is summarized in Table 4.8. This shall be used on all jacket members including appurtenances viz. conductors/risers/boat landing etc. to generate the appropriate wave loading on the structure.

Table 4.8 Marine growth profile

Zone	From Elevation (m)	To elevation (m)	Marine Growth Thickness (mm)
Submerged Zone	(+)6.00	(-)2.000	75
Splash zone	(-)2.00	Mudline	75

Note: Marine growth density = 1.4 MT/m^3

4.11 Hydrodynamic Coefficients

Drag and inertia coefficients for tubulars of the substructure for inplace analysis shall be in accordance with API RP 2A and as tabulated below:

Drag Co-efficient	Members without marine growth (smooth)	0.65
	Members with marine growth (rough)	1.05
Inertia Co-efficient	Members without marine growth (smooth)	1.60
	Members with marine growth (rough)	1.20

Drag and inertia coefficients for tubulars for fatigue analysis shall be in accordance with Section 5.2.2 of API RP 2A and tabulated below for reference.

Drag Co-efficient	Members without marine growth (smooth)	0.5
	Members with marine growth (rough)	0.8
Inertia Co-efficient	Members without marine growth (smooth)	2.0
	Members with marine growth (rough)	2.0

The above coefficients shall be increased by 10% to account for the increase in hydrodynamic loads due to anodes unless calculated otherwise.

The following hydrodynamic factors shall be considered in the inplace analysis.

- Stream function wave theory is considered for the wave load estimation as per API RP 2A guidelines.
- Current blockage factor shall be taken as 0.8 for broadside and 0.7 for end on and 0.85 for diagonal directions for wellhead platform. In case of tripod, the current blockage factor for all the direction will be taken as 0.9.
- Conductor shielding factor is considered as per API RP 2A for wellhead platform.
- Still water depth shall be taken as CD + (LAT) + SS + (50% of Astronomical Tide) + (Storm Surge).

Following hydrodynamic factors shall be considered in the installation conditions**:**

- Wave kinematics factor equal to 1.0 and current blockade factor equal to 1.0 shall be applied in all directions for the installation conditions.
- All members shall be considered as smooth, and effect of conductor shielding shall be ignored for installation condition.

4.12 Geotechnical Data

The geotechnical data for east platform has been extracted from the **Volume 4 – Geotechnical and geohazard assessment report (Doc No: FGTL/BCPL/ED/20-226705/RPT]**.

4.13 Scour

The design scour shall be evaluated based on seabed condition given in the **Volume 4 –**

Geotechnical and geohazard assessment report (Doc No: FGTL/BCPL/ED/20-226705/RPT]. However, minimum scour of 1.5times diameter of pile shall be considered in case if the calculated scour is less.

4.14 Seismic Considerations

The proposed platform is in the Zone–IV earthquake area as per IS-1893. Earthquake accelerations used for design shall be in accordance with the applicable values therein. Hence the platform shall be designed using seismic response spectra as per IS – 1893 and API RP 2A guidelines.

4.15 Structural Steel

The material for primary, secondary and tertiary steel shall be in accordance with Project Specification S-2001.

The following material data shall be used in all structural analyses:

Young's modulus (E)	:	210000 MPa
Shear modulus (G)	:	80770 MPa
Poisson's ratio	:	0.3
Density	:	7850 kg/m³

5.0 FUNCTIONAL REQUIREMENTS

5.1. Platform configuration

The tripod jacket shall be designed with three main piles to accommodate conductors, risers, boat landing, future conductors and risers, Topside facilities including helideck. However, the detailed design by the contractor shall follow this configuration.

5.2. Platform Location and Orientation

The location of the east platform shall be as given in Table 5.1 and the orientation of east platform is given in figure 5.1.

Table 5.1 Platform details

Platform	Location – EVEREST 1830, CM-69		Reference Location	Approximate Water Depth w.r.to. CD (m)
	Easting (m)	Northing (m)		
East platform	612800.0	1813800.0	GS-15-1, GS-15-4 & GS-23-4	10.2

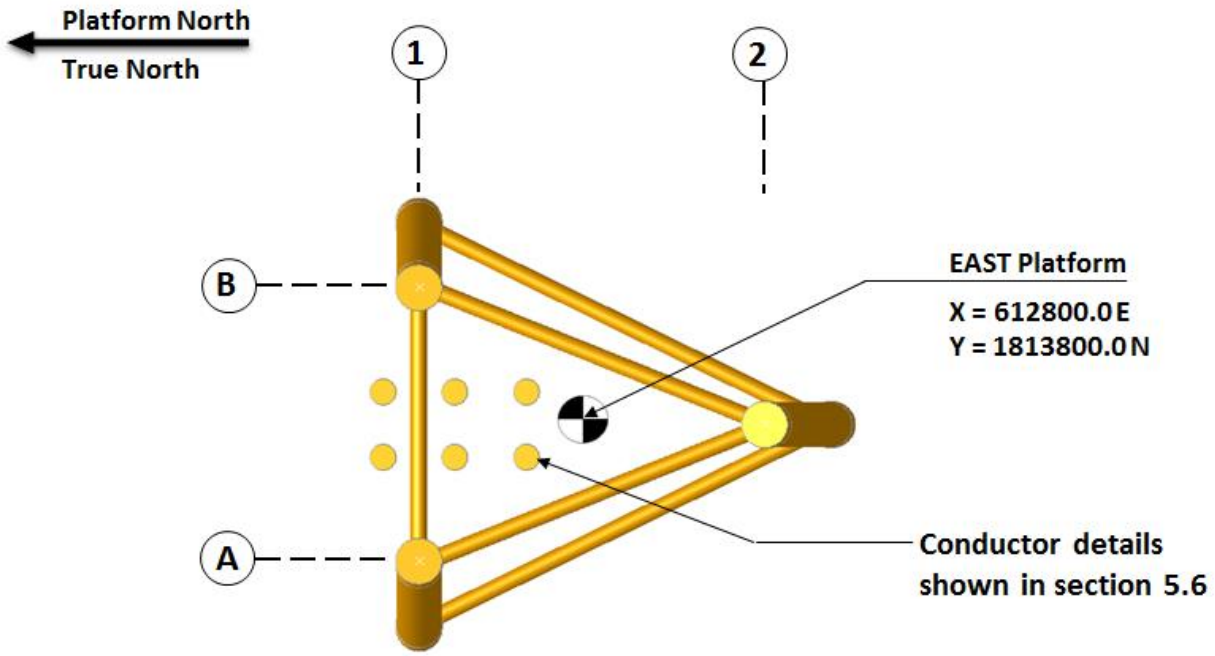

Figure 5.1 East Platform Location / Orientation

5.3. Deck Elevations

Minimum air gap requirement shall be as per API RP 2A for computation of elevation of underside of deck. For this purpose, the water level still shall be considered as CD + (LAT) + 100 % (Astronomical Tide) + (Storm Surge). The cellar deck elevation of EL (+) 18.0 shall be adopted by the LSTK Contractor. Wave forces on equipment piping, platform components placed below the Cellar/ lowest deck shall be accounted for as per API RP 2A.

5.4. Deck Heights

Space between the deck levels shall be sufficient to contain the process equipment, utility systems and piping and provide adequate access for operations and maintenance.

5.5. Conductor Requirement and Orientation

The requirement of number of conductors and its orientation for east platform is summarized in table 5.2 and specified in figure 5.2. A clear gap of 50mm shall be maintained between the conductors and conductor guides for the straight conductors.

Table 5.2 Conductor details

Platform	Number of Conductors		Conductor orientation	Remarks
	Present wells	Future Clamp-on wells	Direction w.r.to TN	
East platform	4*	2	0.0º	*provisions for 4 wells

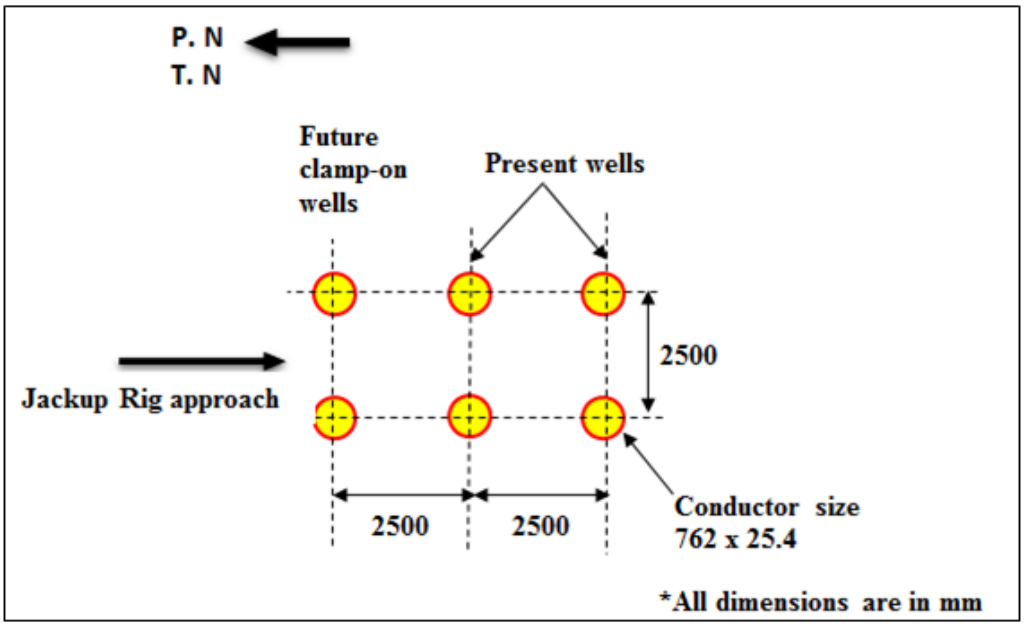

Figure 5.2 Conductor orientation – East platform

5.6. Coil Tubing Unit (CTU) Operation

Sufficient space shall be provided on the Main Deck for CTU operation.

5.7. Risers

One (1) pre-installed 8" Well Fluid riser at east platform shall be provided. The location and length of the riser shall be as per pipeline alignment to be decided during detailed engineering.

5.8. Riser Protectors

No riser protector is envisaged for east platform as the riser is located within the jacket legs.

5.9. Barge Bumpers

No stand-alone barge bumper is envisaged for east platform. The barge bumper shall be integrated with boat landing for the conductor face of east platform.

5.10. I/J Tube

No I/J Tubes are envisaged for the east platform.

5.11. Boat Landings

One three stage Boat Landing on east platform shall be provided on the South Face. The boat landing shall be installed after installation of the jacket and detailed to allow (±) 1.0m elevation adjustment to compensate for variation in the water depth. The boat landings shall also be provided with integrated barge bumpers.

5.12. Mudmats

The platform shall be provided with permanent steel mudmat at the jacket bottom horizontal framing.

5.13. Jacket Walkways and Stairways

The platform shall be provided with permanent grated walkways with handrails at the jacket horizontal framing at EL. (+) 7.00. Stairways shall be provided to interconnect jacket walkway to the sub-cellar deck walkways/intermediate landings. Walkway / handrail arrangement shall be in accordance with the equipment layouts. Sea escape ladders shall be provided for this platform.

5.14. Corrosion Protection

Corrosion protection for the platform shall include:

5.13.1 Corrosion Allowances

Corrosion allowance shall be provided by increase in thickness of structural members in accordance with Table 5.3 for the members in splash zone.

Table 5.3 Corrosion allowances

Item	Location	Corrosion allowance (mm)
1	Submerged Zone	NA
2	Primary members in Splash zone	13.0
3	Other members in splash zone**	6.0
4	Atmospheric Zone	NA

Notes:

1) All steel surfaces in the submerged zone and splash zone shall be protected against corrosion by a sacrificial anode system.
2) All steel surfaces in the splash zone and atmospheric zone shall be painted.
3) At Jacket walkway framing level, a corrosion allowance of 13 mm for the primary and 6mm for Secondary members shall also be applicable. The corrosion considered at this level for jacket in-service analysis has been specified in the applicable section of this document.

** Barge Bumper, Boat landing, Riser/Conductor Protector, Conductor Guides, Mooring Chains, Pump & sump caissons and I-tube/J-tubes.

5.13.2 Cathodic Protection System

A cathodic protection system shall be provided for corrosion protection of the jacket and associated appurtenances. The design conditions pertaining to cathodic protection system shall be as per DNVGL-RP-B401.

The surface area of jacket structural members and appurtenances to be used for calculation of sacrificial anode system requirements shall extend from the top of elevation corresponding to (Chart Datum + AT + SS) to 30 m below seabed.

5.13.3 Painting

All steel surfaces in the splash zone and atmospheric zone, including conductors, shall be painted in accordance with Project Specification. All equipment, stairways and appurtenances such as barge bumpers, boat-landings including their stabbing guides and

conductors at splash zone shall be painted irrespective of the applicable zone.

5.15. Crane

One (1) 5 MT shall be provided for material handling on east platform. Crane location shall be based on the approved equipment layout drawings. Pedestals of requisite height and boom rests shall be provided in accordance with the equipment layouts.

5.16. Living Quarter

One bunk house for 2 pax provision is envisaged in the east wellhead platform.

5.17. Helideck

An integrated main cum helideck shall be provided on the east platform. The helideck shall be suitable for helicopter to be used for the daytime field operations and shall comply with CAP 437 guidelines.

5.18. Passive Fire Protection

Barrier walls with Passive Fire Protection shall be provided based on the recommendations of safety studies.

5.19. Material Handling Facilities

If required, monorails and padeyes shall be provided to facilitate movement of maintenance items to and from laydown areas. The number, location and SWL of these monorails and padeyes shall be based on material handling studies and as indicated, on the equipment layout.

5.20. Laydown Areas

Laydown areas shall be provided based on material handling requirements and shall be located as shown on the equipment layout drawings.

5.21. Stairways, Walkways, Access Ladders and Platforms

Stairways and Landings:

The following parameters shall be used for the primary stair design:

Minimum clear width	:	750mm for wellhead platform
Riser height	:	150 mm to 190 mm

Tread width 250 mm with 6 mm thick chequered plate nosing and carrier plate of 50 mm x 6 mm thick at the ends. Treads shall be made of 30 mm thick grating. The projection of steps shall overlap 20 mm (minimum). The minimum clear landing width for stairs turning 180° shall be 1200 mm. Stairs extending to the jacket walkway level shall be adjustable in length to suit site conditions.

All stairs except the adjustable stair from Jacket Walkway to Sub-Cellar Deck shall have a maximum of 16 risers in any single stair flight. All nosing shall have a non-slip surface. Riser height shall be between 170mm to 200mm. The maximum stair angle with the horizontal shall be between 30° to 38°. Nosing to nosing width (Going) of tread shall be 230mm minimum. Going + 2*Riser height shall be equal to 630mm. The minimum overlap between two threads shall be 20mm.

The material of construction for handrails, kick plates, walkways, stairway treads and landing area grating between boat landing and below cellar deck shall be stainless steel. For all other levels above cellar deck, the material shall be carbon steel.

Deck Walkways:

Deck walkways shall be provided in accordance with the equipment and safety layouts.

Access Ladders:

Access ladders shall have a minimum clear width of 450 mm. Access ladders having more than 3.0 m rise shall be caged above 2.2 m.

Access Platforms:

Access platforms shall be provided to allow personnel easy and safe access to elevated locations. The location and size of the access platforms shall be in accordance with the approved Equipment Layout Drawings.

5.22. Emergency Escape Routes

Based on the requirements of safety studies, adequate means and space for emergency escape shall be provided. Muster areas with sufficient dimensions to accommodate the people on board shall be provided.

Minimum width of primary escape routes : 750mm (for Wellhead Platform)
Minimum width of secondary escape routes: 750mm (for Wellhead Platform)
Minimum headroom for all escape routes : 2200 mm

6.0 LOADING

The load from facilities and structure shall be calculated accurately as per the actual equipment layout prepared for the facility.

6.1. Dead Loads

Dead weight of structural items, architectural items and equipment and piping shall be included.

a) Structural dead weight
b) Miscellaneous steel items
c) Jacket appurtenances
d) Architectural dead weight
e) Fire proofing weight
f) Equipment dead weight
g) Piping dead weight
h) Cable trays and cables
i) Field instruments
j) Valves

The above list is not exhaustive, but all items fixed to the substructure and superstructure shall be included as dead weight for design purposes.

6.2. Operational Loads

Operational loads from process, utility and wellhead area shall be included in the design load calculation. As a minimum, the following shall be included.

- Equipment Content
- Consumables
- Helicopter Operating Loads
- Crane Operating Loads
- Piping contents
- Dynamic Loads from Equipment and Machinery (if applicable)

6.3. Live Loads

Blanket area and Open area Live load to be considered for design of deck, modules and jacket is summarized in Table 6.1.

Table 6.1 Live Loads

Description	Uniform Area Live Loads for blanket design condition / Local Design of deck and module (kPa)	Open Area Live Loads / Global design of jacket and deck for operational condition (kPa)
Main cum helideck	15.00	5.00
Cellar Deck	10.00	5.00
Sub-cellar deck	5.00	5.00
Well bay area	5.00	5.00
Laydown area	15.00	15.00
Walkway & landings	5.00	5.00
Utility and Equipment room	10.00	5.00
Storerooms	10.00	5.00
Building Modules	10.00	5.00

Local design: Design of deck plate and stringers beams

Global design: Design of deck girders truss, jacket and piles.

Open area live load is to be applied only to the area outside the equipment + 0.5m around left open without occupied by escape route, laydown or piping. Area already occupied by any facility; this load shall not be applied.

6.3.1. Carry Down Factors

The following carry down factors shall be applied to the uniform design area live loads for the design of the following parts of the platform:

a. Deck girders and trusses - 0.75

b. Jacket and Piles - 0.75

6.4. Environmental Loads

Loads due to wind, waves and current shall be considered based on the platform orientation and directionality. Loads resulting from sixteen (16) environmental directions (wind, wave and current) shall be considered as a minimum for the east (Tripod) platform. Wave approach along the four orthogonal grid directions and selected diagonal directions which result in the most onerous loads for the platform and foundation shall be included for analyses and design.

Environmental loading parameters for the pertinent design conditions shall be based on the

basic data furnished in Section 4.8. If the selected wave / wind /current approach direction is not within ±10 degrees of the standard approach directions for which the environmental data has been furnished, the data shall be linearly interpolated between the two adjacent directions.

Buoyancy shall be calculated for all submerged components based on the design water depths and wave crest/trough elevations for the pertinent conditions.

For the calculation of hydrodynamic loading and buoyancy, marine growth profile shall be considered on the jacket members and all jacket appurtenances.

Various design parameters for environmental load calculations are highlighted in the following sections. Wind, Wave and Current forces shall be assumed to be collinear and acting simultaneously.

6.4.1. Wind Loads

Wind loads for the pertinent design conditions shall be calculated based on the basic data furnished in Table 4.3 and Table 4.4. Wind speeds shall be based on the applicable gust periods tabulated in Table 4.3 & 4.4 and shall be adjusted for the applicable elevation. Shape coefficients and overall wind load calculations shall be in accordance with Section 2.3.2 of API RP 2A. The wind loads for global design of topsides shall be calculated by assuming that the area between the decks is fully enclosed. The wind load application shall be distributed such that two-thirds of the load is applied above the centroid of the wind area considered and one-third of the load below the centroid. Localized effects of wind loading on topsides members and cold vents shall be considered for local design.

Wind velocity for the installation analyses shall be as specified in section 4.8.7.

6.4.2. Wave Loads

The platform structure and foundation shall be designed for the applicable wave criteria for in-service and pre-service conditions. Wave loads on members and appurtenances not explicitly included in the model shall be accounted for by appropriately modifying the hydrodynamic coefficients of the members that are attached to ensure a proper estimate and distribution of loading.

Wave parameters for the extreme and operating storm conditions shall be calculated based on regular wave theory such as Stokes 5th order wave theory in accordance with API RP 2A. Morison's equation shall be used to calculate the wave forces on the structure.

Wave kinematics factor for extreme and operating storm cases for substructure Inplace analysis shall be considered as 0.88. The wave kinematics factor for substructure fatigue and installation analyses shall be taken as 1.00.

6.4.3. Current Loads

Current velocities based on the design profiles shall be vectorially combined with appropriate wave particle velocities for the design hydrodynamic load calculations. Current blockage factors for the substructure inplace analyses shall be in accordance with API RP 2A. For installation analyses, current blockage shall not be considered.

6.5. Riser Loads

Support reactions from the riser analyses shall be applied at appropriate riser supports. Due consideration shall be given to the fixity conditions in the riser analyses and directionality of the load resultants. Loading from future risers and riser protectors shall also be considered for the in-service analyses, if applicable.

6.6. I/J Tube Loads

I/J tubes are not envisaged for east platform under the current scope of work.

6.7. Crane Loads

Crane loads shall consist of the static and dynamic crane loads data provided by the crane manufacturer. The dynamic crane load cases should consider a range of boom directions to ensure all possible lifting scenarios are adequately checked. A minimum of eight (8) boom directions shall be considered for the deck in-place analysis only.

6.8. Earthquake Loads

Earthquake loading on the combined jacket and superstructure shall be calculated using the response spectrum method and shall be in accordance with the provisions of API RP 2A.

- The response spectrum data shall follow the guidelines of IS-1893 (Zone-IV) with 5% damping. The important factor shall be considered as 2.0 and response spectra Type-III shall be considered to account for the soil foundation system. Response reduction factor of 5.0 shall be applicable.

- For equipment support design, the earthquake loads shall be computed using a horizontal seismic coefficient of 0.12.

6.9. Loadout Loads

Loads due to loadout operations shall be considered for the global design. Appropriate loadout methods for the jacket, deck and other components shall be defined and resultant loads/loading scenarios shall be incorporated in the structural design. The loads, wherever applicable shall include:

- Static and Dynamic Friction and Break-out Loads.
- Wind Loads

The design considerations shall be subject to MWS review and approval.

6.10. Transportation Loads

The platform structural components shall be designed for vessel motions and resultant accelerations during transportation. A route specific tow assessment shall be carried out and design representative sea-states shall be used for the analyses.

Preliminary transportation Analysis

a) For the preliminary transportation analysis, pending a detailed transportation and barge motions analysis, the roll, pitch and heave motions shall be considered in addition to the gravity loading.

b) Inertia loads shall be calculated for the roll, pitch and heave motions mentioned above. The transportation inertia loads shall be combined as roll ± heave and pitch ± heave.

c) The effect of wind load in addition to the above shall not be considered.

d) The following transportation motion criteria shall be used as default.

Barge Type	Single Amplitude (in 10 Sec. Period)		
	Roll	Pitch	Heave
Small cargo barge (L<76 m or B< 23m)	25º	15º	+ 0.2g
Large barges	20º	12.5º	+0.2g
Small Vessel (L<76 m or B< 23m) *	30º	15º	+0.2g

Detailed Transportation Analysis

The final transportation analysis shall consider the following:

I. **Static Stability of barge/structure system:**

a) Intact condition

b) Damaged condition with at least any one compartment of barge flooded.

Prevailing wind speed along the route at the time of transportation of the structure shall be established & considered for calculating the wind forces on the barge freeboard and cargo's surface area for Intact and Damaged conditions respectively. Wind forces shall be calculated as per ABS Rules.

The following barge stability criteria shall be satisfied.

i) The positive range of stability (ignoring strength or down flooding consideration) shall be in the range of 30°- 40°.

ii) The righting energy available to resist capsizing shall be at least 1.4 times the energy required by the design wind to heel the vessel to the same critical angle.

II. **Dynamic motion response analysis for barge/structure system:**

In order to determine the maximum loads imposed on the structure and sea fastenings during the course of voyage from fabrication yard to offshore site an analysis of the dynamic motion response for the structure/barge system shall be performed. This analysis shall include determination of fundamental periods of Roll, Pitch, Heave, Yaw, Surge and Sway motions.

The maximum response motions obtained from the dynamic motion response analysis for various sea states shall be used to compute the inertia loads during transportation. These shall be used for the detailed transportation analysis of the structure being transported.

6.11. Offshore Installation Loads

The jacket and deck structures and other offshore installed components shall be designed for the following offshore installation loading scenarios:

- Jacket Lifting with applicable DAF's
- Jacket Upending and Set-down

- On-bottom Stability
- Pile Driving
- Jacket Levelling (if applicable)
- Deck Lifting with applicable DAF's

Detailed design considerations and loading scenarios are highlighted in the subsequent sections of this document. The design considerations shall be subject to MWS review and approval.

6.12. Load Allowances and Contingencies

This allowance shall be added to the estimated substructure and superstructure dead weight.

Platform in-service and pre-service design loads, applied either globally or locally, shall include contingencies, as defined in Table 6.2. However, no load contingencies shall be considered for checking the pile tension capacities for uplift condition.

Table 6.2 Load allowances and contingencies

S. No	Description	Contingency (%)
1	Substructure Dead weight	12.00
2	Superstructure dead weight	15.00
3	Building Architectural Items	20.00
4	Equipment and Piping Dead Weight	20.00
5	Equipment and Piping Operating Weight	20.00

Note:

- Above stated contingencies shall be considered in all in-service Analysis.
- Above stated contingencies shall not be applied for pile force analysis under uplift condition.

6.13. Load Combinations

Load Combinations used for the analyses of the substructure have been included in Table 6.3 and for superstructure have been included in Table 6.4.

Table 6.3 Load combination for Substructure analysis

Load Case	Blanket load condition		Operational load condition		Storm condition with empty equipment*	Operating load condition with Earthquake
	Operating case	Storm case	Operating case	Storm case		
Operating wind, wave & current load	1.00	-	1.00	-	-	-
Extreme wind, wave & current load	-	1.00	-	1.00	1.00	-
Computer generated dead load	1.00	1.00	1.00	1.00	1.00	1.00
Deck non-generated dead load	1.00	1.00	1.00	1.00	1.00	1.00
Uniformly distributed deck area live load (Blanket Live Load without any deduction in area)	0.75	0.75	-	-	-	-
Open area live load	-	-	1.00	0.50**	-	0.50**
Laydown area live load	1.00	0.75	1.00	0.75	-	0.75
Deck grated area excluding wellhead grated area	-	-	-	-	-	-
Equipment & piping Operating contents load	-	-	1.00	1.00	-	1.00
Equipment & piping dry (dead) load	-	-	-	-	1.00	-
Instrumentation / Electrical / safety	-	-	1.00	1.00	1.00	1.00
Crane Dead load	1.00	1.00	1.00	1.00	1.00	1.00
Crane Operating load	-	-	-	-	-	-
Riser Dead load	1.00	1.00	1.00	1.00	1.00	1.00
Earthquake load	-	-	-	-	-	1.00

Note:

***** To check the capacity of the piling under the maximum uplift force. For uplift condition of substructure and piles only weights of permanently placed equipment and piping shall be considered

** Open area live load shall be 50% during extreme storm environment & earthquake condition.

Table 6.4 Load combination for Superstructure analysis

Load Case	Blanket load condition		Operational load condition		Operating load condition with crane oper. loads	Operating load condition with Earthquake
	Operating case	Storm case	Operating case	Storm case		
Operating wind, wave & current load	1.00	-	1.00	-	-	-
Extreme wind, wave & current load	-	1.00	-	1.00	1.00	-
Computer generated dead load	1.00	1.00	1.00	1.00	1.00	1.00
Deck non-generated dead load	1.00	1.00	1.00	1.00	1.00	1.00
Uniformly distributed deck area live load (Blanket Live Load without any deduction in area)	0.75	0.75	-	-	-	-
Open area live load	-	-	1.00	1.00	1.00	0.50
Laydown area live load	1.00	1.00	1.00	1.00	1.00	0.75
Deck grated area excluding wellhead grated area	-	-	0.50	0.50	0.50	-
Equipment & piping Operating contents load	-	-	1.00	1.00	-	1.00
Equipment & piping dry (dead) load	-	-	-	-	1.00	-
Instrumentation / Electrical / safety	-	-	1.00	1.00	1.00	1.00
Crane Dead load	1.00	1.00	1.00	1.00	1.00	1.00
Crane Operating load	-	-	-	-	1.00	-
Riser Dead load	1.00	1.00	1.00	1.00	1.00	1.00
Earthquake load	-	-	-	-	-	1.00

6.14. Weight and C.O.G. Reports

An effective weight control procedure shall be developed, documented and followed throughout design and construction. The procedure shall collect, collate and distribute weight information to the Contractor's project team. The NTE (Not to Exceed) weights for the proposed installation methodology shall be established.

A detailed weight inventory of all equipment, bulk materials and consumable to be installed on the platform shall be maintained in the form of a Weight Control Report.

This report shall be computer generated and the weight assessment of each jacket and deck shall be made for the following conditions.

- Inplace conditions (for dry and operating conditions)
- Transportation conditions
- Offshore lifting conditions
- Loadout conditions

This report shall be prepared separately for all the jackets and decks, which are identified to be lifted separately offshore.

The weight control report shall incorporate appropriate contingencies based on the reliability / accuracy of the source of weight information. These contingencies shall be added in a statistical manner to obtain the best estimate of the component weight.

The load contingencies stated in Table 6.2 shall be applied to the weights arrived at in the weight control report and shall be used in the pre-service and in-service design of the various components.

As engineering / procurement work progresses, subsequent weight control reports shall provide updated weight information which shall be used to estimate the margin on weight available at that stage. This margin shall not be less than 5% till the time of weighing of the decks.

7.0 DESIGN REQUIREMENTS

7.1. General

This section provides an overview of various requirements to be considered for the analyses and design of the platform components.

The platform structural components and foundations shall be designed to ensure that they are adequate for safety, strength, stability and serviceability requirements during all phases of pre-service and in-service conditions, as per API RP 2A and AISC. In addition, the foundations shall be designed with the necessary factors of safety in accordance with API RP 2A.

Certain components such as stiffened plate and shell elements may not be adequately covered by the above codes. For the design of these components, the requirements of DnV

or other internationally accepted codes shall be applicable.

7.2. Topside

The platform shall be sized and designed in accordance with the approved equipment layout. Equipment layout and arrangement shall be adequate to house all equipment with necessary clearances and meet all space requirements for personnel movement and maintenance purposes and necessary provision in the layout.

The topside consists of sub-cellar deck, cellar deck and main deck cum helideck. The elevations are preliminary, and this shall arrive at optimum elevations during detailed engineering. However, the cellar deck elevation shall not be lower than EL (+) 18.0m.

7.3. Design Philosophy

Primary and major secondary steelwork for the decks and jacket (including foundation) shall be proportioned to ensure adequate strength and serviceability throughout all phases of installation and in-service conditions.

a) The jacket and topsides shall be designed to withstand the extreme and operating storms that occur at the site.
b) Structural analyses and design shall be in accordance with the requirements of API RP 2A and AISC using working stress design methods.
c) Primary steel members shall include:
   - Decks/Modules - all truss members, deck primary beams/girders, crane pedestal and deck legs, helideck main framing including trusses, vent/flare boom.
   - Jacket - all legs, skirt sleeves, piles, vertical/inclined/horizontal bracing, barge bumpers and load bearing installation aids, transition piece, conductor framing.
d) Secondary steel members shall include:
   - Decks/Modules - deck plate, grating, secondary beams, stringers, equipment support beams, walkways, ladders, stairs and handrails, access platforms, crane boom rest.
   - Bridges - walkways, ladders, stairs and handrails.
   - Jacket - boat landing, walkways, casing/caissons, installation aids (including conductor guide barrels), appurtenances and their supports and mud-mat, skirt pile guides, riser/conductor protector.
e) Pile shall be grouted with the Jacket Structure (Legs and or Skirt Sleeve).

All structural analyses shall be performed using a computer program applicable to the design of offshore structures using SACS. The extent of the analyses shall be to demonstrate the adequacy of the structures under all envisaged phases and anticipated loading.

7.4. Design Guidelines

The design of all major structural members shall meet the following guidelines based on latest version of API RP 2A:

a) Member slenderness ratio shall be less than 80 (Kl/r < 80) for Jacket elevation braces. Member slenderness ratio shall be less than 100 (Kl/r < 100) for all other members of the Jacket and Topsides. The buckling coefficient K shall be chosen for each member in accordance with API RP 2A recommendations. The buckling length for X braces shall be in accordance with API RP 2A recommendations using the longer segment length.

b) Rolled tubular member diameter to thickness ratio shall be chosen such that the ratio (Fy*D)/(E*t) < 0.069 is achieved for the Jacket elevation braces. For all other members of the Jacket and Topsides, the diameter to thickness ratio shall be maintained between 20 and 60 (both inclusive) (20 < D/t < 60).

c) Concentric tubulars (for grouted jacket legs/skirt sleeves with piles) shall have a diameter to thickness ratio (D/t) < 100.

d) Diameter to thickness (D/t) ratio of Un-grouted Jacket Legs shall not exceed 50.

e) The minimum thickness of major jacket tubular members shall be 12 mm. The thickness of jacket members in splash zone shall not be less than 25 mm.

f) The minimum thickness of deck truss tubular members shall be 8 mm.

g) Major rolled shapes shall be compact sections as defined by AISC.

h) The minimum thickness of structural plates and flange/web of rolled sections as defined by AISC shall not be less than 6 mm.

i) Back-to-back, battened and lattice type built-up sections shall not be used.

j) Beams and Plate Girders shall be designed in accordance with AISC specifications and shall incorporate the following guidelines:

- All plate girders shall be compact sections as defined by AISC**.**
- Web, top and bottom flanges at a given section shall be of the same grade of steel and symmetric about the beam's axes.

- Full penetration welds shall be used between flanges and web of plate girders / box girders/ built-up girders.

k) Member stresses shall be checked at the ends of members and throughout their spans in accordance with API RP 2A and AISC. Member stresses due to aspects, which are not specifically covered in the computer analysis, shall be investigated by manual calculations to ensure that stress and deflection limitations are not exceeded.

l) Structural design shall be based on Working Stress Design. Permissible stresses and Factors of Safety shall be in accordance with API RP 2A or AISC wherever applicable.

m) A one-third increase of basic allowable stresses shall be considered for in-service load combinations including extreme storm loads.

n) Deck plates on the cellar deck and main deck shall be chequered type with a raised pattern surface and the minimum thickness shall be 8 mm. Building module plating shall be plain type and have a minimum thickness of 6 mm. The minimum thickness of deck plating in laydown areas shall be 10 mm.

o) Clear span of plating and grating shall not exceed 1200mm.

7.5. Analysis Requirements

All structural components of the east field platform shall be analysed and designed for the following in-service and pre-service conditions.

7.5.1. In-Service Analyses

The following analyses shall be carried out for the substructure, superstructure and its foundation system.

i) Inplace Analyses

ii) Fatigue Analysis

iii) Seismic Analysis

7.5.2. Pre-Service Analyses

The following pre-service analyses shall be carried out for the substructures and superstructure as applicable:

i) Loadout Analysis

ii) Transportation Analysis

iii) Lift Analysis

iv) Floatation and Upending Analyses

v) On-bottom Stability Analysis

vi) Pile driveability analysis

8.0 SUBSTRUCTURE ANALYSES AND DESIGN

8.1. General

The substructure shall be checked for integrity using various global structural analyses to demonstrate the adequacy of the platform substructure for the in-service conditions and pre-service conditions. The requirements specified herein can be considered as the minimum consistent with good practice.

8.2. Jacket Inplace Analysis

Inplace analyses of the jacket shall be performed for the following design conditions:

- Extreme storm conditions (100-year return period environmental loads), applicable discipline operating loads and Open Deck Area Live and gravity loads
- Operating storm conditions (1-year return period environmental loads), applicable discipline operating loads, Open Deck Area Live and gravity loads
- Extreme storm conditions (100-year return period environmental loads), applicable discipline (dry/empty) and gravity loads for Uplift conditions.

The following guidelines shall be used as guidance in carrying out the inplace analysis of jacket and foundation.

- The platform substructure, foundation and appurtenances shall be designed for the maximum loads resulting from the combinations highlighted above.
- An integrated model of the jacket, deck and pile foundation representing the global stiffness of the platform shall be utilized for the inplace analysis.
- Conductors, risers, boat landing, and other jacket appurtenances shall be included in the model for gravity and hydrodynamic loading purposes and shall be excluded for global stiffness calculations.
- Jacket primary members in the splash zone shall be modelled in corroded condition (13 mm thickness reduction) to capture reduced stiffness of these members in the structural model.

- Wave loads on these members shall however be captured in un-corroded condition by using appropriate hydrodynamic overrides.
- Jacket walkway level primary members shall be modelled in corroded condition with an average corrosion of 6 mm since they occur outside the splash zone.
- Appropriate wind areas shall be modelled to capture wind loads in eight (8) directions.
- This overall increase to account for anodes and any other minor appurtenances not explicitly included in the model shall be 15%.
- The platform shall be analysed for a minimum of eight (8) wave approach directions.
- Water particle velocities and accelerations calculated using a regular Stokes 5th wave theory with a wave kinematics factor of 0.88 shall be used for the substructure inplace analysis.
- Conductor shielding factors shall be specified for the conductor group array in accordance with Section 2.3 of API RP 2A.
- Drag and inertia forces on individual members shall be calculated using Morison's equation.
- The soil model shall be simulated by non-linear springs characterized by P-Y, T-Z and Q–Z curves.
- Scour effects shall be considered.
- The depth till which disturbed soil conditions are considered shall be in accordance with the spud can penetrations described in the respective Soil Investigation reports.
- Load combinations for the substructure inplace analysis shall be in accordance with API RP 2A.
- All jacket members and joints shall be checked in accordance with API RP 2A requirements for the loads and stresses due to design load combinations.
- Unless otherwise noted on this basis, permissible stresses and factors of safety shall be as recommended in API RP 2A and AISC.
- A one-third increase of basic allowable stresses shall be considered for load combinations including extreme storm loads.

The design pile penetration shall be sufficient to develop adequate capacity to resist the maximum computed axial compression or pull-out loads with an applicable factor of safety in accordance with API RP 2A.

The minimum factor of safety for load combinations involving extreme storm shall be 1.5 while the minimum factor of safety for load combinations involving operating storm shall be 2.0.

Stresses and deflections along the entire pile length shall be established from the analyses results for the design conditions highlighted above. Design stresses shall be determined at all critical sections along the pile and shall be checked in accordance with the requirements of API RP 2A. Basic allowable stresses shall be increased by one-third for design loads due to extreme storm conditions. Pile deflections at mudline shall be reported for load combinations involving operating storm.

8.3. Seismic Analysis

A platform structural model for seismic analysis that represents stiffness, weight, buoyancy, and mass distribution in sufficient detail and accuracy shall be used for the analysis.

The design loads reflecting the operating conditions shall be used for the mass generation. The topside loads shall correspond to the normal operating conditions, excluding deck crane hook (operating) loads. The jacket loads shall include the main structure and appurtenances weights, including marine growth.

The overall mass shall include:

- Jacket and topside dead load
- Applicable topside live load
- Appurtenances
- Entrapped water for flooded members
- Marine growth
- Added mass for the submerged members.

Modal analysis shall be performed with retained degrees of freedom at the Jacket leg framing joints and other selected framing joints on the Jacket and topsides to determine the fundamental frequencies of the platform. Natural Frequencies shall be determined for the fundamental modes of translation and torsion and an additional number of modes based on the analysis requirements.

The structural model for seismic analysis shall be similar to the inplace analysis model. The structural model shall correctly represent the distribution of stiffness and mass of the jacket and topsides.

Sufficient number of modes shall be selected to ensure adequate cumulative mass participation (a minimum of 90% for the horizontal directions) for the response analysis. These modes shall include at least two modes having the biggest overall response from each of the three principal directions plus any significant torsional modes.

The earthquake loading on the combined jacket, linearized foundation and superstructure shall be calculated by dynamic response analysis using the response spectrum method and in accordance with the provisions of API RP 2A.

A 70% increase in allowable stresses shall be used for seismic load combinations for code checks for the jacket and deck members. A 33% increase in allowable stresses shall be applicable only for the equipment supporting beams in accordance with the provisions of API-RP2A.

8.4. Jacket Fatigue Analysis

The tubular joints of the jackets shall be checked for fatigue in accordance with API RP 2A using a deterministic fatigue analysis.

The factor of safety on fatigue life shall be in accordance with API RP 2A for wellhead platform.

The computer model shall be similar to inplace analysis model. The stiffness of all appurtenances shall be excluded from the analysis similar to the inplace analysis model.

Fatigue analysis of the jacket structures shall be carried out in accordance with the API RP 2A recommendations. A deterministic fatigue shall be performed using the given fatigue wave environmental data.

8.5. Jacket Loadout Analysis

A structural analysis of the jacket shall reflect the loadout method either by skidding or by

trailer to check the integrity of jacket during the loadout operation.

The computer model of the jacket from inplace analyses shall be modified to suit the pre-service conditions. The jacket supports shall reflect the actual condition during loadout including support loss if any.

The basic design loads for the loadout analysis of the jackets shall include:

a) Self-weight of the Jacket, including all pre-installed appurtenances and installation aids
b) 5% of the loadout weight, applied in the direction of the trailer movement direction to account for sudden breaking forces for trailer loadout.
c) Wind loads corresponding to the environmental conditions at yard during loadout. A typical wind speed of 10 m/s shall be considered.

All jacket members and joints shall be checked in accordance with API RP 2A requirements for the loads and stresses due to design load combinations.

No increase in allowable stresses shall be considered for the jacket loadout analysis for member and joint code checks.

Necessary local checks shall be performed to demonstrate the structural adequacy of the barge for the loads envisaged during all stages of loadout.

8.6. Jacket Transportation Analysis

The transportation analysis jacket structure and sea-fastening shall be designed for forces arising from barge motion along the route due to encountering environmental forces from wave and wind.

Dead loads should be considered together with weights for all preinstalled lifting gear, sea fastening, loose ship items, etc.

In absence of detailed barge motion analysis for the following preliminary inertia loads specified in design criteria can be used.

The transportation inertia loads shall be combined as:

± Roll ± Heave + W (Self Weight) [Beam Sea]

± Pitch ± Heave + W (Self Weight) [Head Sea]

± 0.8 Pitch ± 0.6 Roll ± Heave + W (Self Weight) [Quartering Seas]

± 0.6 Pitch ± 0.8 Roll ± Heave + W (Self Weight) [Quartering Seas]

The effect of wind load in addition to the above need not be considered.

All jacket and joints members shall be checked in accordance with API RP 2A requirements for the loads and stresses due to design load combinations.

A one-third increase in allowable stresses shall be considered for the jacket transportation analysis.

8.7. Jacket Lift Analysis

The jackets shall be lifted off the transportation barge by the derrick barge. The offshore lifting off the transportation barge shall be carried out at a designated location close to the site where the jackets are to be installed. A lift analysis shall be carried out to ensure that the jacket structure is adequate for the design forces encountered during offshore lifting.

The following scenarios shall be analysed:

a) 50/50 sling load distribution: All slings connected to the lifting trunnions carrying equal loads.

b) 75/25 sling load distribution: Unequal sling load distributions. The four-sling lifting arrangement to be used for jacket lifting shall be achieved by simulating conditions where a diagonally opposite pair of sling carries 75% of the lift weight while the other diagonal pair carries 25% of the lift weight.

The computer model for lift analysis shall be the same as the model used for loadout and transportation analysis.

The following changes shall be ensured:

- Eccentricities of lifting trunnions shall be modelled using offsets.
- Slings shall be modelled as weightless rigid-end links with appropriated releases.
- The hook point shall be modelled above the calculated COG with a minimum sling

angle of 60° to the horizontal (actual sling angle shall also be checked w.r.t. derrick barge's main hook height limitations and a smaller angle may be used if required).

The basic load cases shall comprise of self-weight of structure and appurtenances. In addition, loads from the upending slings, lifting trunnions, buoyancy tanks (if used), shackles and rigging platform(s) shall be included.

Variations in COG with reference to the calculated COG position shall be established and the corresponding load cases shall be included in the design load combinations. A variation equal to 2% of the linear dimension of the COG along the plan direction towards the lift points shall be considered.

To simulate the COG shift during lift, a couple shall be applied in the computer model at the lifting points on the jacket such that the sling forces increase further. This COG shift shall be applied for the 50/50 sling load distribution case only.
The load combinations shall be created with appropriate Dynamic Amplification factors as explained below.

- 50/50 sling load distribution: load combinations shall be created with a DAF of 2.0 and with a DAF of 1.35.
- 75/25 sling load distribution: load combinations shall be created with a DAF of 1.35 and 1.15.

All jacket and joints members shall be checked in accordance with API RP 2A requirements for the loads and stresses due to design load combinations.

No increase in allowable stresses shall be considered for the jacket lift analysis.

8.8. Jacket Floatation and Upending Analysis

The jackets shall be lifted off the cargo barge and lowered into water to a free float condition. This necessitates a free float analysis and subsequent upending analysis of these jackets.

Floatation and upending analyses shall be carried out to:

i. Investigate the stability, bottom clearance, barge crane hook loads and buoyancy requirements at initial floatation and successive stages of the jacket upending.
ii. Develop a safe jacket upending procedure that includes the proposed flooding sequence in combination with a crane hook load within the operating range of the nominated derrick barge.

A minimum clearance between the bottom of the jacket and the seabed of 3.0m during the entire upending operation shall be maintained.

The computer model for floatation and upending analysis shall be the same as the model used for lift analysis.

The basic load cases shall comprise of self-weight of structure and appurtenances. In addition, loads from the upending slings, lifting trunnions, buoyancy tanks (if used), shackles and rigging platform(s) shall be included. The buoyancy of individual items shall be correctly specified in the model.

The objective of the analysis shall be to ensure that the jacket structure can be free floated with sufficient reserve buoyancy and upended in a hook-assisted upending operation with sufficient clearance from the mudline. The jacket shall be freely floating and stable on its own accord without the assistance of any external applications. The jacket shall also be checked for legs accidentally flooded for one leg damaged condition. Under this circumstance also, the jacket shall be freely floating and stable.

In addition, sensitivity studies shall be performed on the jacket at its equilibrium position to determine the stability of the jacket under the following cases:

- One of the compartments accidentally flooded. Damaged compartments shall be any one compartment with flood valves and vent line.
- C.O.G shift cases shall be considered in accordance with Marine Warranty Surveyor guidelines.
- A minimum mud line clearance of 3.0 m shall be maintained throughout the upending operation for the intact condition of Jacket.

A minimum reserve buoyancy of 12% over the estimated weight shall be ensured in the

design. With any one buoyancy component fully flooded, the reserve buoyancy shall be minimum of 6%.

Adequacy of the jacket structure for the design forces during all stages of the upending shall be checked in accordance with API RP 2A with no increase in allowable stresses for intact condition.

All upending trunnion connected members shall be designed for the sling forces in the load combination with DAF 2.0. All other members shall be checked for the sling forces in the load combination with DAF 1.35.

8.9. Jacket On-Bottom Stability Analysis and Mudmat Design

The on-bottom stability of the jacket shall be investigated for conditions prior to and during the installation of the piles, under gravity and environmental loads. The stability of the jacket against bearing, overturning and sliding failures shall be checked to ensure that the factors of safety meet the minimum requirements recommended by API RP 2A. The mudmat and the jacket structure shall be designed for the resultant soil pressure during on-bottom condition.

The computer model shall be on bottom condition for weight and hydrodynamic loads. Members in splash zone shall be modelled in un-corroded condition and no marine growth shall be considered.

The loads for the on-bottom stability check shall include:

- Gravity Loads, including jacket self-weight, all pre-installed appurtenances and the weight of rigging platforms and buoyancy tanks (if applicable)
- Buoyancy, including that for the pre-installed appurtenances.
- Weight of any pile sections supported on the jacket, prior to driving.
- Environmental Loads applicable for installation conditions

Drag and inertia coefficients of the jacket members shall be considered smooth in accordance with API RP 2A. No reductions due to wave kinematics and current blockage shall be considered. Hydrodynamic coefficients for modelled structural members supporting non-modelled jacket appurtenances and anodes shall be modified to account for the

environmental loads on the jacket appurtenances.

The jacket shall be checked for stability against bearing, sliding and overturning due to the installation wave/current loading along with eccentricity of the gravity loading. The minimum factors of safety against overturning, bearing and sliding failures shall be in accordance with API RP 2A.

The required mudmat area, configuration and layouts shall be determined based on the requirements from the on-bottom stability analysis. The integrity of the jacket structure shall be checked for the design forces from the on-bottom stability analysis and the resultant soil pressure on the mudmat.

Mudmats shall be designed with basic allowable stresses for the gravity condition. A one-third increase in allowable stresses shall be considered for the cases where the environmental wave and current are included in the load combinations.

Supporting beams, knee braces and end connections shall be designed such that maximum stresses are within the allowable limits as per API RP 2A/AISC.

8.10. Pile Foundation Design

The pile foundation shall be designed for the in-service and pre-service conditions in accordance with API RP 2A requirements. The foundation system shall be sufficient to develop adequate capacity to resist the maximum computed loads with an appropriate factor of safety in accordance with API RP 2A.

Stresses and deflections along the entire pile length shall be established from the analyses results for the in-service design conditions highlighted in the previous sections.

Design stresses due to axial loads and bending moments shall be determined at all critical sections along the pile and shall be checked in accordance with the requirements of API RP 2A. Basic allowable stresses shall be increased by one-third for design loads due to extreme storm conditions. The pile wall thickness make-up shall include allowances for under-drive and overdrive.

Pile axial capacities shall be calculated based on the design unit friction and end bearing capacities from the soil reports.

Pile driveability analysis using wave equation software (GRLWEAP) shall be carried-out to ensure that the proposed piles are driveable to the design penetration with the selected hammers. The pile wall thickness and pile add-on lengths shall be checked for dynamic stresses from driveability analysis.

Soil resistance to driving (SRD) shall be estimated based on the site-specific geotechnical design data. The following criteria shall be used.

Table 8.1 Continuous Driving

	Case 1 - Continuous / Lower bound – Plugged condition			Case 2- Continuous / Lower bound – Unplugged condition		
	Internal	External	End bearing	Internal	External	End bearing
CLAY	0%	50%	100%	25%	50%	100%
SAND	0%	100%	100%	50%	100%	100%

Table 8.2 Restart Driving

	Case 3 - Restart / Upper bound – Plugged condition			Case 4 - Restart / Upper bound – Unplugged condition		
	Internal	External	End bearing	Internal	External	End bearing
CLAY	0%	85%	100%	42.5%	85%	100%
SAND	0%	100%	100%	50%	100%	100%

Table 8.3 Dynamic Soil Parameters

Soil type	Damping coefficient (Sec/m)		Quake (mm)		Remarks
	Shaft	toe	Shaft	toe	
Clay	0.656	0.033	2.54	2.54	
Sand	0.164	0.492	2.54	2.54	

Pile shoe length shall be more than one time diameter of pile. Pile shoe thickness shall be minimum 1.5 times the thickness of pile (minimum of all segment of pile).

A maximum of 90% hammer efficiency shall be considered during pile drivability analysis for sizing of Hammer.

Driven pile refusal criteria shall be in accordance with API RP 2A. Maximum static and

dynamic stresses shall not exceed API RP 2A recommended values.

The pile wall thickness make-up shall be designed to allow for the possibility of pile driving refusal prior to reaching the design penetration (underdrive) and overdrive beyond design penetration. Appropriate amount of underdrive/overdrive allowance shall be provided to account for shifting up/down of increased pile wall thickness at mud-line vicinity.

Based on the soil profile, design penetration and driveability considerations, a minimum of 3.00 meter underdrive allowance and a 3.00 meter overdrive allowance shall be provided. These values shall be reviewed and adjusted based on the final design penetration and driveability studies.

9.0 SUPERSTRUCTURE ANALYSIS AND DESIGN

9.1. Deck Inplace Analysis

A 3-dimensional rigid space frame computer model of the topsides structure shall be generated with all members contributing to its stiffness. The computer model shall be prepared based on centerline co-ordinates with model framing lines matching with the element centerline. Offsets shall be provided to members to more correctly represent their true location.

All dead loads of the structure shall be considered in the design.

Live loads on the structure such as secondary loads, variable loads, drilling loads, supply, operating loads, crane loads shall be applied at appropriate locations.

Dry and operating weights of all mechanical, electrical and instrumentation equipment and panels shall be applied to the model as per the equipment general arrangement drawings and vendor data available.

Dry and operating piping bulk item weights relevant to pre-service and in-service design conditions shall be included in the model as per data from the piping layout drawings and mark-ups as a line/pressure load. Point loads are also applied to cater for heavy support loads wherever required.

The E&I bulk item weights are applied as a separate load case in the model as per data from the E&I layout drawings and mark-ups as a line/pressure load. Point loads are also applied to cater for heavy support loads wherever required.

Inplace analyses of all topsides shall be performed for the following design conditions:

- Extreme storm conditions (100-year return period environmental loads), applicable discipline operating loads and Open Deck Area Live and gravity loads
- Operating storm conditions (1 year return period environmental loads), applicable discipline operating loads and Open Deck Area Live and gravity loads
- Crane operating loads, applicable discipline operating loads and Open Deck Area Live gravity loads.
- Extreme storm conditions (100-year return period environmental loads), applicable discipline operating loads and without live loads to check the pullout case.

The decks shall be designed for the maximum loads resulting from the design conditions highlighted above.

9.2. Deck/Module Loadout Analysis

The purpose of the load out analysis is as follows:

1. To check the integrity of the structure for the different support conditions during loadout operation
2. To calculate the support reactions required to check the capacity of the load arrangement.

The computer model for the loadout analysis shall be based on the model used for inplace analysis with the following modifications:

- The joint co-ordinates shall be transformed to represent the correct elevation for the loadout.
- Proposed loadout support assembly based on the trailer arrangement shall be modeled appropriately.

9.3. Deck Transportation Analysis

The transportation analysis deck / module structures and sea-fastening shall be designed for forces arising from barge motion along the route due to encountering environmental forces from wave and wind.

Dead and equipment loads should be considered together with weights for all preinstalled lifting gear, sea fastening, loose ship items, etc.

In absence of detailed barge motion analysis for the following preliminary inertia loads in motion criteria specified in design criteria section can be used.

The transportation inertia loads shall be combined as:

± Roll ± Heave + W (Self Weight) [Beam Sea]

± Pitch ± Heave + W (Self Weight) [Head Sea]

± 0.8 Pitch ± 0.6 Roll ± Heave + W (Self Weight) [Quartering Seas]

± 0.6 Pitch ± 0.8 Roll ± Heave + W (Self Weight) [Quartering Seas]

The effect of wind load in addition to the above need not be considered.

9.4. Deck Lift Analysis

All Deck/modules checked for the lifting forces based on single point or multi-point lifting arrangement.

The following scenarios shall be analysed:

a) 50/50 sling load distribution: All slings connected to the lifting padeyes carrying equal loads.

b) 75/25 sling load distribution: Unequal sling load distributions. The four-sling lifting arrangement to be used for lifting shall be achieved by simulating conditions where a diagonally opposite pair of sling carries 75% of the lift weight while the other diagonal pair carries 25% of the lift weight.

The computed model for lift analysis shall be similar to the model used for loadout/transportation analysis with the following changes:

- All support assemblies/sea fastening etc. which are not present during lifting shall be deleted.
- Eccentricities of lifting padeyes shall be modelled using offsets.
- Slings shall be modelled with appropriate releases as weightless rigid-end links.
- The hook point shall be modelled above the calculated COG with a minimum sling angle of 60° to the horizontal.

The analysis of the structure is carried out using the computer-generated model and

applying loads and suitable combinations that are likely to act during lift analysis. Two possible conditions are considered for lift analysis.

The design loads shall be combined to simulate the two (2) lifting scenarios listed above. The load combinations shall be created with appropriate Dynamic Amplification Factors as explained below.

- 50/50 (equal) sling load distribution: load combinations shall be created with a DAF of 2.0 and with a DAF of 1.35. This combination shall also include the COG shift.
- 75/25 (skew) sling load distribution: load combinations shall be created with a DAF of 1.35 and 1.15

All members shall be checked in accordance with API RP 2A and AISC requirements for the loads and stresses due to design load combinations. Member check parameters such as effective length factors, bending moment, amplification factors etc. shall be in accordance with API RP 2A and AISC.

No increase in allowable stresses shall be considered for the lift analysis.

10.0 JACKET APPURTENANCES DESIGN

10.1. General

Jacket appurtenances shall be designed for appropriate forces due to their functional requirements. The design requirements specified herein are minimum.

10.2. Walkways

The jacket walkway members shall be designed for the following requirements.

a) Jacket walkways members shall be designed for a uniform loading of 5.0 kN/m^2.
b) Horizontal members in the splash zone shall be designed for wave slamming forces as per API RP 2A. A one-third increase in allowable stresses may be permitted for the wave slam load cases. The slam coefficient, C_s, shall be taken as 5.5.

10.3. Lifting Trunnions and Upending Trunnions

Trunnions and padeyes used for the lifting and upending operations shall be design in

accordance with API RP 2A and relevant guidance from marine warranty requirements.

Suitable Dynamic factors, COG shift factors, skew load factors, lateral loads shall be considered in the design to make the lifting aids safe for offshore lifting.

10.4. Cathodic Protection

Cathodic protection (sacrificial anodes) for jacket shall be designed as per in accordance with Project Specification and DNVGL-RP-B401 – Recommended Practice, Cathodic Protection Design.

The distribution of anodes along the jacket members shall be based on jacket member surface area proportion and the same shall be obtained by boundary element method.

10.5. Stabbing Guides and Installation Aids

All stabbing guides and installation aids shall be designed for the following loads as a minimum:-

1. Horizontal loads 10% of the static weight of the item being installed
2. Vertical impact force 20% of the static weight of the item being installed

Design considerations shall include:

- The guides/installation aids shall be designed such that they fail prior to permanent deformation of any part of the permanent structure. The permanent structural members shall be designed in such way so that they can withstand significantly more load than the aids.
- Any deflections shall be within the elastic limit of the material.

A one-third increase in allowable stresses shall be permitted for stabbing guide design.

10.6. Shear Keys

Shear keys shall be designed and provided on skirt piles and skirt pile sleeves as per API RP 2A guidelines.

Shear keys on the piles shall be provided over sufficient length including under drive and overdrive allowance to ensure that the length of pile in contact with the grout has adequate

number of shear keys.

10.7. Hydrostatic Collapse

All buoyant members including buoyancy tanks (if any) shall be checked for hydrostatic collapse during pre-service conditions for the most onerous loading from the following conditions:-

a) Maximum water depth reached during pre-service operations, with a factor of safety of 2.0.

b) Accidental complete submergence condition i.e. hydrostatic pressure at mud level with a factor of safety of 1.5.

Tubulars shall be checked for in-service condition for hydrostatic collapse in accordance with API RP 2A. The factor of safety for axial compression case shall be taken as 1.5 and 2.0 for extreme and operating environmental conditions respectively.

10.8. Boatlanding

Three stage Boat landing shall be provided with the following.

- Vertical rub-strips along the berthing face.
- 10 MT Mooring bollards for each end of the boat landing.
- Two swing ropes at each of the landing for access from boat to jacket.
- Stairway between landing to jacket walkway level.

Boat Landing shall be designed for ±1m installation tolerance of jacket.

Boat landings and associated connections shall be designed for a combination of dead loads, live loads, environmental loads and boat impact loads using following load combinations:

i. Dead load + Live load of 500 kg/m² on each landing.

ii. Dead load + Boat impact load at different points on the berthing face.

iii. Dead load + Extreme environmental load.

Boat impact load shall be derived based on vessel impact energy of 3.0 T-m.

10.9. Barge Bumpers

Barge bumpers (if required) shall be designed for the following loads.

- Vessel impact directly in the middle one-third height of post. Energy to be absorbed by the system shall be 30.4 T-m.
- Vessel impact laterally in the middle one-third height of post. Energy to be absorbed by the system shall be 11.0 T-m.

For structural design the load shall be treated as a concentrated load. Local denting of the vertical post shall be neglected. Analysis of jacket framing members shall be carried out for the boat impact loads on barge bumper.

10.10. Conductor Guide Framing

The conductor guide framing shall be designed for the forces arising from conductor installation especially the top conductor framing at the walkway level. Weight of conductor segments initially passing through the conductor guide with an impact factor of 1.5 shall be considered as design force.

10.11. Vortex Shedding

All jacket members and appurtenances shall be checked for vortex shedding due to design steady currents from extreme and operating environmental conditions.

Jacket members and appurtenances shall also be checked for vortex shedding due to wind during fabrication and installation phases. Wind velocities for the check shall reflect the design conditions during these phases.

10.12. Grouting System

A reliable grouting system for grouting the jacket with the piles shall be provided.

a) A minimum of two grout distribution ports shall be provided for each leg or sleeve compartment. The grout distribution system shall be arranged so that an even distribution of grout injection can be done during grouting.
b) In case substructure leg extensions are provided in design, the grout inlet shall be taken below mudline.

c) Two additional grout ports shall be provided for diver or ROV intervention at appropriate location.

d) A grout seal shall be used to confine the grout inside the leg/main pile and sleeve/skirt pile. The system shall be adequate to withstand the design grout column weight. The minimum grouting pressure shall be determined for both jacket leg and skirt pile sleeves pressure during grouting operations.

e) Grout Seals with two seals shall be provided at each location.

11.0 TOPSIDES DETAILED DESIGN

11.1. General

This section provides the general guidelines for the analysis, design and detailing of the deck structural components that are not explicitly included in the computer models for the primary structure design.

These components and their connections to the main structure shall be designed for strength, stability and serviceability in accordance with the requirements of API RP 2A, AISC and other referenced standards. The design shall be consistent with the intended usage and proposed support arrangement.

The secondary structural components shall be analysed and designed using the approved structural analyses software and generally accepted engineering practices. Each component and its support arrangement shall be analysed and designed based on the pertinent local design forces and load conditions.

The following sections enumerate the design criteria for typical deck structural components. Any other components required for the project shall be suitably designed with appropriate criteria approved by the COMPANY.

11.2. Tubular To Girder/Beam Joints

The joints of tubular members framing onto deck plate girders or rolled sections shall be checked for the following requirements.

- Local flange bending
- Local web yielding

- Chord web buckling
- Stiffener column stability

The web stiffeners shall be designed to carry in compression the permissible axial load of the brace. Webs of such joints shall be reinforced to meet shear area requirements as required by in-service and pre-service analysis. Allowable stresses shall be in accordance with AISC.

11.3. Girder to Deck Leg Connections

The girder to deck leg joints shall be designed for load transfer by shear either using closed form solutions or by finite element analysis. Allowable stresses shall be taken not more than 0.6 Fy.

11.4. Deck Plate and Grating Design

The local design of deck plating and grating shall be based on the applicable loads. Clear span of plating and grating shall not exceed 1200mm. Plates shall be reinforced if concentrated loads are directly placed on plating.

11.5. Secondary Beams

Deck secondary beams shall be designed for the minimum design loads specified for the area. The beams shall also be checked for a combination of any imposed loads from equipment, pipe supports, access platforms and open area loads. Strength checks shall be in accordance with the requirements of AISC.

11.6. Monorail Design

Monorail design shall be designed as per AISC requirements for impact loads which are summarized below:

a) Vertical Load = 125% of static load
b) Lateral Load = 20% of (static load + trolley weight)
c) Longitudinal Load = 10% of maximum wheel load

The maximum deflection of the monorail due to safe working load shall not exceed L/500 for all beams and L/250 for cantilever beams.

11.7. Crane Pedestal Design

Crane Pedestal shall be included in the structural analysis model for the in-service and pre-service condition and designed as part of the topsides analysis. The crane dead loads and live loads, dynamic thrust load and moments shall be used based on the crane dynamic rating obtained from manufacturer load chart or material handling study. If the crane pedestal is also used for diesel storage, the weight of diesel shall be applied as part of loads.

The deflection of the top of pedestal from the supporting deck shall be limited to H/200 under design loads, where H is the height above the deck.

11.8. Crane Boom Rest

Crane boom rests shall be designed for the maximum loads to which they are subjected when the boom is in stowed position for extreme/ operating/ seismic environmental loads, whichever is maximum. In addition, the boom rests shall be designed for an impact load equal to 1.50 times the static load from the boom, excluding environmental loads. Member and joint checks shall be as per AISC and API RP 2A. Crane boom rests shall be designed for 10% of the crane boom weight in horizontal directions at the top of the boom rest.

11.9. Vortex Shedding

Vortex shedding analysis will be carried out for all topsides members and appurtenances to ensure that slender tubular members will not be liable to failure due to vortex shedding induced oscillations in wind. All structural members are designed to avoid vortex induced vibrations (VIV) in the in-place condition. To accomplish this, the members shall satisfy the avoidance criteria as specified in this section. Vortex shedding analysis shall in general follow the DNV-RP-C205.

11.10. Stairways and Walkways

The stairway and landing layouts shall be in accordance with the latest equipment layout drawings.

Stairways and landings shall be designed for the following load combinations:

- Dead load + live loads of 5 kN/m^2
- Dead load + extreme storm three second wind gusts and/or extreme storm maximum wave whichever is applicable.

Member and joint checks shall be as per AISC and API RP 2A. A one-third increase in allowable stresses shall be permitted for combinations with extreme environmental loads.

11.11. Handrails

Handrails shall be provided around the perimeter of all open decks and on both sides of stairways, sides of jacket walkways and sides of helideck walk ways. Handrails around the perimeter of lay down areas, loading and unloading areas shall be removable type. Removable type handrail shall be fitted with Socket/Collar. The Socket/Collar shall be fitted with kick plate.

Handrails shall be 1100 mm in height with three (3) horizontal tubulars and a 100 mm X 6 mm kick plate. The top rail of the handrail shall be supported at maximum 1500 mm intervals.

Handrails shall be designed for the following loads:

- Handrails shall be designed to withstand 100 kg concentrated load acting vertically or horizontally at any point.
- Handrails in the wave zone shall also be designed to withstand maximum extreme storm wave loading.

The minimum size and grade of material to be used for the handrail is given in Table below.

Member	Indian Standard	International Standard
Vertical Post	60.33 mm φ X 5.54 mm	2" X 0.218" (SCH80S) , Stainless Steel Pipes conforming to ASTM A312 and Grade 316L
Top Horizontal member	60.33 mm φ X 5.54 mm	2" X 0.218" (SCH80S) , Stainless Steel Pipes conforming to ASTM A312 and Grade 316L
Other horizontal members	48.26 mm φ X 5.08 mm	1.5" X 0.2" (SCH80S) , Stainless Steel Pipes conforming to ASTM A312 and Grade 316L
Kick Plate	100 x 6	Stainless steel : ASTM A240 Grade 316L

11.12. Ladder

Minimum width of vertical ladder shall be 450 mm. 20 mm Diameter Rung shall be provided at 250 mm interval. Rungs shall be slotted through the end supports and welded all around the Rung. Vertical ladders shall be provided with Cage protection when height of Ladder

exceeds 3000 mm.

The inclined ladder shall be at angles of 50 degree to 75 degrees from the horizontal

11.13. Access Platform

Access platforms shall be provided, where required, to allow personnel easy and safe access in elevated locations. Access platforms shall be designed for live loads of 5 kPa and any piping or other imposed loads. The minimum height of access platform from top of plating to bottom of beam shall be 2.2 m.

12.0 HELIDECK DESIGN

12.1 General

The analysis and design of Helideck integrated with the super structure module shall be carried out as per the data and load combinations given below. The Helideck shall be designed complying with CAP 437 guidelines.

Helideck supports & framing members shall be designed for impact loading from helicopter landing.

12.2 Static Helicopter Data

The helicopter data referred from CAP 437 (Ch.3, sec 1.2, table 1) is summarised in Table 12.1. However, OIL shall confirm the helicopter to be used for the field operations.

Table 12.1 Helicopter data

Detail	Bell 212	Bell 412
Gross Weight (MT)	5.10	5.40
Main Rotor Diameter (m)	14.63	14.02
Overall length (m)	17.46	17.13
Perimeter 'D' marking	17.0	17.0

12.3 Helicopter landing dimensions

A diameter of 17m is required for Bell 212 and 412 type helicopters as per CAP 437 and 18m shall be provided as a diameter for the helideck.

12.4 Helideck Requirements

The helideck shall be provided with functional requirements as stated below as per CAP 437 and other safety requirements.

- All functional requirements, including lighting, fire protection system, markings on helideck, protective perimeter fencing, deck drainage system etc. shall be in accordance with CAP 437.
- Helideck safety net shall slope upwards at 10 degrees with the outer edge level with the flight deck surface.
- The helideck safety net shall be fixed with stainless steel clamps with the framing in such a way that head of the bolts should be on top.
- A wind direction indicator shall be as per CAP 437 guidelines.

12.5 Design Loads

Helideck supports & framing members shall be provided with necessary vortex shedding to avoid vortex induced vibrations.

Helideck firefighting & solar panel platform design (Global):

Uniformly distributed area live loads for helideck (including firefighting & solar panel platform) global design are 200 kg/m^2.

Helideck Beam design (Local):

Helideck shall be designed for following helicopter loading conditions.

Table 12.2 Design cases

Helideck Design cases		Load Combination
Case1	Helicopter Normal Landing	1.5 MTOM+50 Kg/m² + Dead Load + Wind Load
Case 2*	Helicopter Emergency Landing	2.5 MTOM+50 Kg/m² + Dead Load + Wind Load
Case 3	Helicopter at Rest	1.0 MTOM+200 Kg/m² + Wind Load in extreme storm condition

Note : *Critical position of the Helicopter landing & Crush Landing cases shall be evaluated in the analysis at Center, various position at 1.5 m inside periphery in between above to positions.

12.6 Load Combinations

Load combinations for helideck global analysis is summarized in table 12.3.

Table 12.3 Load combination for Helideck global analysis

Load Case	Static helicopter under operating condition	storm condition	Helicopter landing condition	Helicopter Crush Landing condition
Operating wind	1.00	-	-	-
Extreme wind	-	1.00	-	1.00
Computer generated dead loads and dead loads of solar panel platform, firefighting platform and equipments	1.00	1.00	1.00	1.00
Uniformly distributed deck area live load on helideck	1.00	0.50	-	-
Static helicopter load	1.00	-	-	-
Landing condition load with impact at various position on helideck	-	-	1.0	-
Crush Landing condition load at various position on helideck	-	-	-	1.0
Live loads on Grated areas	0.50	-	0.50	0.50
Live load on Solar panel platform and firefighting platform	0.50	-	0.50	0.50

Notes:

- Four orthogonal & four Diagonal wind directions shall be considered for extreme and operating storm conditions.
- Wind loads on Solar panels shall be included in the analysis (wherever applicable).

13.0 ACCEPTANCE CRITERIA

13.1 General

Member stresses shall be checked at the ends of members and throughout their spans in accordance with API RP 2A and AISC. Member stresses due to aspects, which are not specifically covered in the computer analysis, shall be investigated by manual calculations.

Stresses in steel shall conform to those allowed in API RP 2A or AISC, wherever as applicable.

13.2 Allowable Stresses

Unless otherwise noted on this basis, allowable stresses and factors of safety shall be as recommended in API RP 2A and AISC.
A one-third increase of allowable stresses shall be considered for load combinations including extreme storm loads.

13.3 Allowable Deflections

Allowable platform deflection shall be limited to H/200, where, "H" is the height of the deck above the mudline. Pile deflections shall also be checked at the mudline for the operating storm load combinations. These deflections shall be limited to 0.1 times the respective pile diameter.

Deflections shall be checked for the live loads and actual equipment loads. Deck plating above main /secondary beams shall not be considered for checking the deflection of beams.

Deflections for equipment supporting beams shall be limited to criteria based on equipment operating requirements specified by vendors or those specified in Table 13.1, whichever is less.

Table 13.1 - Permissible Deflection Values

Condition	Deflection Limit	
	Beam	Cantilever
Members supporting sensitive equipment	L / 500	L / 250
Other Structural Members	L / 360	L / 180

Plating Design shall be for a maximum deflection restriction of L/250 or half the plate thickness whichever is lesser, where L is the distance between the support points.