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VOLUME – II

SECTION – 3.0

DESIGN CRITERIA

FOR

S&SRP

(Sump Caisson and SWLP Casing Replacement Project)




**OIL AND NATURAL GAS CORPORATION LIMITED
INDIA**

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3.0 DESIGN CRITERIA

3.1 GENERAL

This Design Criteria together with the Scope and Description of Work (Basic Bid Work) comprise the Design requirements. The bid package includes functional specifications/standard specifications. Design requirements given in these specifications shall also be followed by the Contractor. Legend Sheets, Notes, Process Flow Schematics etc. are also included in bid package to convey the Basic Bid Work for the project. The technical requirements given in the above referred drawings shall be considered as part of design criteria.

A description of the Project, the associated facilities which form part of this contract, are given in the introduction to the scope and description of work document.


The design of the new facilities as per bid design criteria, specifications, & drawings is the ultimate responsibility of the Contractor. In doing this, the Contractor is expected to follow the guidelines of the preliminary design and other safety guidelines as presented herein for the works to be performed to ensure that its intent is fulfilled. The Contractor shall also ensure that his final design complies fully with the design philosophy, safety aspects and criteria as furnished herein.

3.1.1 Objectives

The Contractor's design must be done in a manner to ensure the following objectives:

- Provide a safe and protected facility that meets the requirement as detailed in the bid document and consistent with industry accepted and good engineering practice.
- Provide facility that complies with the design parameters and International Codes and Standards.
- Install the most appropriate equipment that will allow optimum operation of the facility for the given design conditions which will require a minimum of supervisory, operating and maintenance personnel.
- Provide maximum protection to prevent environmental pollution.

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- Provide optimum use of platform space yet allow sufficient space for operation and maintenance functions, and future expansions.
- Provide convenient and safe escape route through pathway, walkway, ladders, staircases etc.
- Provide shutdown system dedicated to a fail-safe design

3.1.2 Basic Environmental Conditions

Bidder shall also refer Structural Design Criteria and Pipeline Design Criteria

3.1.2.1 Climatic conditions

Sl.No	Equipment	Condition	Temperature deg C	Humidity
1	Turbine	Site rated	36.7	90
2	HVAC	Summer	35.6	68
		Monsoon	30	90
		Winter	18.3	65
		Inside condition	20(+ or -)1	50(+)5(-) 10
3	All other equipment / General	Ambient Max / min	40/16	90

3.1.3 Orientation and Facilities Layout


3.1.3.1 Facilities Layout

The Contractor shall be responsible for site survey and verification of proposed locations keeping in view the space requirement for safe operation and maintenance of the new facilities. It is essential that all plans for the surveying of any location be reviewed with the Company representative prior to performing the location survey.

3.1.3.2 Equipment Layouts

For new well platforms as well as the bridge connected Process Platform, Contractor shall develop deck equipment layout keeping in view operational, maintenance and future expansion requirement. Besides, safety and environmental protection conforming to international standards shall be adhered to. Contractor shall ensure that all the facilities are adequately covered to prevent damage due to dropped objects. Further, Contractor shall ensure that the facilities (including space for future facilities) on cellar deck shall be weather protected with main deck and helideck.

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3.1.4 Noise and Vibration

The Contractor shall follow in general and the following specifically –

- Functional specifications 5002, Equipment Noise Limit and 5004 – Specification for equipment vibration included in the bid document.
- Recommended noise limits for specific work areas
- Vibration limits for human exposure.
- Guidelines to minimize noise and vibration problems.

3.1.5 Material of Construction


The Contractor shall note that material specifications for equipment, preinstalled risers, piping & valves required for the project have been included in the bid package. The Contractor shall follow these specifications. No deviations to the MOC is permissible

The Contractor shall note that in this bid document, wherever NACE Carbon Steel or Carbon Steel with MR-01-75 is specified, it shall mean NACE Carbon Steel meeting the requirement of NACE MR-01-75 specification. This requirement shall be applicable to piping components, instruments and other related facilities. The Contractor shall clearly specify this requirement while procuring the necessary equipment/piping.

3.1.6 Engineering Requirements:

- All equipment shall be designed for saliferous environment and outdoor location on an offshore platform, unless otherwise stated.
- All equipment and its accessories, installed on the platform shall be designed and selected / certified for electrical area classification defined in electrical area classification drawings and data sheets forming part of bid package.
- Equipment layout on deck, within skid and of each equipment shall be examined for adequate access for convenient operation, maintenance and replacement of components on all four sides and also overhead/ underneath. There should be enough space available for the movement of material handling devices and necessary lifting hooks shall be provided, for area / equipment where permanently installed material handling facilities or deck cranes do not have access. All around equipment a clear space of 1000 mm shall be provided for taking up any repair maintenance activities.

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d) All packaged equipment shall be supplied as skid mounted fully assembled, piped, wired and tested as per specifications. Structural steel base frame of skid shall be designed for single lift operation. Drip pan with suitably connected drains shall be provided so as to avoid spillage of fluids/ liquids on deck, for all equipment prone to leakage/ moisture condensation.

e) All equipment shall be designed and selected for continuous duty, for a design life unless specified otherwise.

3.2 Process
Process design criteria is enclosed as SECTION-3.2 in the bid document.

3.3 Piping
Piping design criteria is enclosed as SECTION-3.3 in the bid document.

3.4 Structural
Structural design criteria is enclosed as SECTION-3.4 in the bid document.

3.5 Electrical
Electrical design criteria is enclosed as SECTION-3.5 in the bid document.

3.6 Instrumentation
Instrumentation design criteria is enclosed as SECTION-3.6 in the bid document.

3.7 Mechanical

Mechanical design criteria is enclosed as SECTION-3.7 in the bid document.

3.8 Pipeline

Pipeline design criteria is enclosed as SECTION-4.0 in the bid document

4.0 Codes and Standards

The equipment, packages and systems shall be designed, selected and engineered in accordance with latest editions of applicable codes/ standards/recommended practices.

Codes and standards referred in equipment specifications shall be followed for the respective equipment.

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SECTION – 3.0

DESIGN CRITERIA PROCESS

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3.2. PROCESS DESIGN BASIS

3.2.1. INTRODUCTION

Oil and Natural Gas Corporation Limited (ONGC), hereinafter called as 'ONGC', is engaged in exploration and exploitation of Western Offshore Field in the Arabian Sea on the continental shelf of Western India. The field is well developed with an extensive infrastructure of wellhead platforms, process platforms and pipelines. Western offshore consists of three assets viz. Mumbai High Asset, Neelam & Heera Asset and Bassein & Satellite Asset.

Company is confronted with issues owing to aging assets and thus, several facilities have been identified across several platforms for replacement. Under the following project, the items which are to be replaced have been enlisted and their scope has been defined.

This section defines details of process facilities & utilities and the modification works envisaged in the project. It outlines the design parameters for designing these facilities. It shall be read in conjugation with scope of work and P&IDs which will provide general guideline and design criteria which shall be followed for designing various process & utilities.

3.2.2. GENERAL REQUIREMENTS

This document provides the design criteria of various process facilities and utilities envisaged in the project. The sizes, capacities, specifications and drawings furnished in this bid package for various facilities are minimum to be provided by the Contractor. It is the Contractor's responsibility to verify all the design/ data before proceeding for the detailed design and engineering. In case of any discrepancy between various 106062documents, Contractor shall refer the same to the Company for resolution and proceed with their design and engineering only after Company's decision with no impact on cost and schedule of the project. Under the scope of this contract, Contractor shall perform all necessary process simulations using Aspen HYSYS software (latest version) and design calculations and consider adequate design margins while specifying piping/equipment/instrumentation. Contractor's responsibility also includes carrying out hydraulics studies (intra-platform), safety studies, review of operability aspects of the facilities and incorporate findings of the same while designing the facilities. Any deviation shall require Company's approval.

The indicative process & utility flow diagrams and indicative P&IDs are enclosed in the bid document. The basic purpose of these drawings is to provide indicative details of various facilities envisaged on existing wellhead platform/details of modification at various process. However, these are minimum indicative and need to be supplemented/modified/updated based on the scope of work indicated in bidding documents. Incomplete/missing details/systems, if any, shall be discussed and finalized during bidding stage and same shall be incorporated within firm scope of work. Also, the piping specs indicated in bid P&IDs shall be reviewed and revised wherever necessary, based upon safe operational requirements & approved Piping Material

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Specification (PMS). The identified process and utility tie-in locations are indicative, to be firmed up during pre-engineering. The utilities are to be fetched through existing network on respective platforms. Contractor shall develop detailed process & utility design basis, process & utility flow diagrams and material & energy balances for different cases, as applicable and indicate in these criteria and design the process and associated utility systems, accordingly. In case, simulation results show higher flow rates and varying pressure/temperature ranges for some applications, the more conservative figures/ranges shall be used for design within the scope of this contract. The process and associated utility systems shall be suitably designed for the above referred higher flow rates/ranges. Accordingly, Contractor shall develop detailed process & utility balance and flow diagrams.

Contractor shall develop detailed Piping and Instrumentation Diagrams (P&IDs), Cause & Effect Diagrams, SAFE charts etc. incorporating all vendor information. P&IDs shall also include distribution P&IDs for all the utilities as applicable, including vent/flares, drains, fire water, fire suppression, dry chemical powder etc. and bridge inter-connections showing piping, instrumentation, valve etc. Contractor shall prepare data sheets and specifications for all the equipment, instruments, valve etc. Sufficient margins shall be taken on operating parameters viz. pressure/ pressure drop, temperature, flow, level etc. to take care of complete operating range.

Contractor shall ensure that P&IDs shall include all required instrumentation for local as well as for remote monitoring and control of critical process parameters including but not limited to pressure, temp., flow, level etc. and shall confirm to safe operations. Additional instrumentation, if required, based upon safety study as well as operational necessity shall be provided as part of firmed scope under this project without time and cost implication.

Contractor shall develop size/routing/distribution of various utilities (namely Vent/HP flare/LP flare/LLP Flare, Open/Closed Hydrocarbon Drain, Open Deck Drain, Utility Air, Fire water, Utility water, Potable water, Inert gas, Fuel Gas etc. as applicable and incorporate the same in detail engineering documents & drawings.

Contractor shall update existing as-built drawings for the intended modifications. Wherever as-built drawings of existing facilities are not available, Contractor shall develop drawings for the intended modifications inclusive of nearby identifiable facilities and update them to an as-built status.

Contractor shall ensure that the design of platforms and modification works shall meet the relevant codes and standards requirements. A typical list of applicable codes is included in this Bid Package. This, however, cannot be taken as an exhaustive list and various codes and standards as mentioned in functional specifications as well as those applicable as per good engineering practices shall also form the basis and shall have to be followed by the Contractor in consultation with Company/ Company's engineering consultant.

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All the process, utility, safety and instrumentation systems shall meet the requirements of API-RP-14C - "Recommended Practice for Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms – Latest Edition".

Engineering shall also be done for all specified future facilities wherever indicated and appropriate location, space and hook-up provisions shall be kept. Relevant doc/drawings shall be generated for review and approval.

3.2.3. SAFETY STUDY

Contractor shall engage an internationally reputed third party agency having expertise in carrying out HAZID study. The workshop shall be convened at the design centre wherein observations/ recommendations shall be deliberated in presence of/ with Company's representatives/ Engineering Consultant/ Vendor the firmed-up recommendations shall be incorporated in relevant documents/drawings and after their approval, P&IDs shall be issued for "Approved for Construction (AFC)

3.2.4. DOCUMENTATION

A typical list of process documents/ drawings/reports is given below. The list shall be supplemented with additional documents/ drawings/ reports as felt necessary during detail engineering.

- Process & Utility Design Basis
- Process Simulation Report
- PFDs, UFDs & Material Balance
- Detailed P&IDs
- Process Calculation Report
- Hydraulic Calculation
- Vent Dispersion Analysis Report
- Flare radiation study
- Alarm & Trip Schedule
- Equipment Data Sheets
- Instrument Data Sheets
- Cause & Effect Chart
- SAFE Chart
- Equipment List
- Line List
- Operating Manual
- Process control philosophy
- Black start philosophy
- Isolation philosophy
- Pre-engineering survey for modification.

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Process calculation report shall include sizing calculations for process/ utility piping, equipment / vessels, safety / relief valves, control valves, choke valves, orifice plates etc. However, sizing of equipment/ instruments for which vendor's information are required, preliminary calculations shall be submitted initially. Subsequently, same shall be updated by the Contractor based upon vendor's information and shall be re-submitted for Company's review and approval. Also, hydraulic calculations shall be updated based upon final routing/ layout etc. as per actual piping isometrics, and re-submitted for Company's review and approval.

Contractor shall submit all native files related to process simulation and sizing calculations for review by the Company.

Contractor to note that based upon review and approval of aforesaid calculations/ documents/ drawings only, P&IDs shall be considered for carrying out Safety Study.

3.2.5. ABBREVIATION

<i>AFC</i>	Approved for Construction
<i>API</i>	American Petroleum Institute
<i>ABP</i>	After Bean Pressure
<i>ABT</i>	After Bean Temperature
<i>BWPD</i>	Barrels of water per day
<i>HAZOP</i>	Control System HAZOP
<i>CFD</i>	Computational Fluid Dynamic
<i>DCS</i>	Distributed Control System
<i>ESD</i>	Emergency Shutdown
<i>FSD</i>	Fire Shutdown
<i>FTHP</i>	Flowing Tubing Head Pressure
<i>FCV</i>	Flow Control Valve
<i>FG</i>	Fuel Gas
<i>GTG</i>	Gas Turbine Generator
<i>HAZOP</i>	Hazard & Operability Analysis
<i>HAZID</i>	Hazard Identification
<i>HMI</i>	Human Machine Interface
<i>IUG</i>	Instrument & Utility Gas
<i>IUA</i>	Instrument & Utility Air
<i>KOD</i>	Knock Out Drum
<i>MOC</i>	Material of Construction
<i>MPV</i>	Multi-Port Valve
<i>MPFM</i>	Multi-Phase Flow Meter
<i>NFPA</i>	National Fire Protection Association
<i>NPSH</i>	Net Positive Suction Head
<i>PFD</i>	Process Flow Diagram
<i>P&ID</i>	Piping & Instrumentation Diagram

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<i>PI</i>	Pressure Indicator
<i>PT</i>	Pressure Transmitter
<i>PSHL</i>	Pressure Switch High-Low
<i>PSV</i>	Pressure Safety Valve
<i>PCV</i>	Pressure Control Valve
<i>ppmw</i>	Parts per million by weight
<i>ppb</i>	Parts per billion
<i>RTU</i>	Remote Telemetry Unit
<i>SAPCV</i>	Self-Actuated Pressure Control Valve
<i>SCADA</i>	Supervisory Control And Data Acquisition
<i>SDV</i>	Shutdown Valve
<i>SSV</i>	Surface Safety Valve
<i>SIL</i>	Safety Integrity Level
<i>SSSV</i>	Sub Surface Safety Valve
<i>STHP</i>	Shut-in Tubing Head Pressure
<i>SBHP</i>	Shut-in Bottom hole pressure
<i>TI</i>	Temperature Indicator
<i>TT</i>	Temperature Transmitter
<i>UFD</i>	Utility Flow Diagram

3.2.6. UNITS OF MEASUREMENT

Quantity	Units
Length	Millimetre, (mm)
	Meter, (m)
	Kilometre, (km)
Diameter of Pipe	Inches, (")
Diameter of Vessel	Millimetre, (mm)
	Meter, (m)
Time	Seconds, (s)
	Minutes, (min)
	Hours, (hr)
	Day, (d)
Temperature	Kelvin, (K)
	Degree Centigrade, (°C)
Volume	Cubic Meter, (m ³)
Mass	Kilogram, (kg)
Mass Flow	Kilogram per hour, (kg/hr)
Molar Flow	Kilogram mole per hour, (kg mole/hr)
Liquid Flow	Barrels per day, (BPD)
	Cubic Meter per hour, (m ³ /hr)
	Litre per minute, (LPM)
Gas Flow	Million Metric Standard Cubic Meter per Day, (MMSCMD)

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	Standard cubic Meter per hour, (Sm ³ /hr)
Pressure	Kilogram per square centimetre gauge, (kg/cm ² g)
	Atmosphere, (atm)
Velocity	Feet per second, (ft/s)
	Meter per second, (m/s)
Viscosity	Centipoise, cP
Density	Kilogram per Cubic Meter, (kg/m ³)
Mass Enthalpy	Kilojoule per kilogram, (kJ/kg)
Mass Heat Capacity	Kilojoule per kilogram per °C, (kJ/kg-°C)
Thermal Conductivity	Watt per meter per Kelvin, (W/m-K)
Normal Condition	1 atm @ 0 °C
Standard Condition	1 atm @ 15.56 °C

3.2.7. CODES AND STANDARD

The following codes and standards (latest revision) shall be followed as minimum requirement:

API RP 14C	Recommended Practice for Analysis, Design, Installation and Testing of Basic Surface Safety Systems for Offshore Production Platforms.
API RP 14E	Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems.
API RP 14G	Recommended Practice for Fire Prevention and Control on Open Type Offshore Production Platforms.
API RP 14J	Recommended Practice for Design and Hazard Analysis for Offshore Production Facilities.
API SPEC 12J	Specification for Oil & Gas Separators.
API STD 520 (Part- I)	Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries-Part 1, Sizing & Selection
API RP 520 (Part- II)	Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries-Part 2, Installation
API STD 521	Guide for Pressure-Relieving and Depressurizing Systems.
API RP 2030	Guideline for Application of Water Spray Systems for Fire Protection in the Petroleum Industry.
NFPA – 15	Standard for Water Spray Fixed Systems for Fire Protection.
NFPA - 13	Standard for Installation of Sprinkler System

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3.2.8. GENERAL DESIGN BASIS

All the process, utility, safety and instrumentation systems shall meet the requirements of API RP 14C – “Recommended Practice for Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms” – Seventh Edition” Latest Edition.

3.2.9. DESIGN PRESSURE

Unless stated otherwise design pressure in general shall be considered as per the following:

- When the maximum operating pressure is up to 70 kg/cm² (1000 psi), design pressure shall be maximum operating pressure plus 10% or 1 kg/cm² whichever is higher.
- When the maximum operating pressure exceeds 70 kg/cm² (1000 psi), design pressure shall be maximum operating pressure plus 5% or 7 kg/cm² whichever is higher.
- If there is possibility of vessel being subjected to vacuum during normal operation (including start-up & shutdown) it shall be designed to withstand external pressure of 1.055 kg/cm².
- Design pressure for storage tank shall be full of water plus 150 mm water column and (-) 50 mm water column vacuum.

3.2.10. DESIGN TEMPERATURE

Unless stated otherwise design metal temperature in general shall be considered as per following

- For vessel operating at 0°C and above, the design temperature shall be maximum operating temperature plus 15°C.
- For vessel operating below 0°C, the design temperature shall be minimum operating temperature.

3.2.11. ENVIRONMENTAL DATA

1. Sea Water Temperature

Sea water normal temperature varies between 26 °C to 28 °C and the minimum seabed temperature is 22.78 °C (73°F). Seawater minimum and maximum temperature is as follow:

Minimum temperature: 22 °C

Maximum Temperature: 30 °C

2. Ambient Temperature

Air quality : Saline, humid, corrosive.

Min. temperature : 16 °C (60 °F)

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Max. Temperature : 40 °C (104 °F)

3. Relative humidity

90% (Max.) @ 40 °C

4. Rainfall

The rainfall for facilities design shall be taken as 100 mm rain in 2 hours and this intensity to last over a period of 20 minutes.

3.2.12. DESIGN LIFE

25 years

3.2.13. DESIGN MARGINS

Unless otherwise indicated elsewhere or in codes and standards, the following design margins as a minimum will be considered for various systems:

Service	Design Margins
Separators	25% Surge Factor on maximum well fluid flow and 15% swell factor on maximum oil/condensate flow rate
Gas Conditioning System	10% Design Margin on maximum capacity. All equipment, piping, instrumentation shall be designed accordingly.
Storage and Pumping System	80% of liquid filled storage capacity to be considered. 10% margin on balance equipment (including pumps), piping and instrumentation shall be considered.
Utility System	10% margin to be considered on maximum consumption for various consumers. Entire system including piping to be designed accordingly.
Process Piping	10% margin to be considered on maximum flow of gas and liquid.

3.2.14. VENT SCRUBBER – BHS PLATFORM

Vent system of BHS is to be replaced along with Vent Scrubber (V-1090) and upstream piping.

Design Variable	Value
Design Pressure	3.5 (kg/cm ² g)
Design Temperature	160°C

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For more details, following documents to be referred:

- Mechanical Scope of Work
- Marked up P&ID 7134-PR-BHS-PID-3001

3.2.15. WELL FLUID HEATER

Two number of existing WF heaters (E-1150/E-1160) of SHG platform shall be removed and new WF heaters shall be installed at new location. New WF heaters shall be shell and tube type heat exchangers.

Well fluid heaters shall be designed for the following design conditions:

DESIGN VARIABLE	VALUE	
Capacity (MMKcal./hr)	3.8	
Hot Oil Flow Rate	78,043 kg/hr.	
Well Fluid Flow Rate	6,57,044 kg/hr.	
	Shell Side (Hot Oil)	Tube Side (Well Fluid)
Operating Pressure (Kg/cm ² g)	4.5	15.7-12.2
Operating Temperature (oC)	234 (in) - 160 (out)	23 (in) – 30 (out)
Design Pressure (Kg/cm ² g)	12	21
Design Temperature (°C)	340	104
No. of Passes	1	1

For details refer:

- Marked up P&ID 7134-PR-SHG-4003 & 4004
- Datasheet attached in Annexure 1

3.2.16. SUMP CAISSON

Sump Caissons at ICP, NLP and HRA are to be dismantled and one-on-one replacement can be taken based on following design parameters. Both Sump Caisson at SHP (S-1060 and S-1070) are to be dismantled and a Sump Caisson of appropriate combined capacity is to be installed, based on following design conditions. Existing Floatation Pile type Sump Caisson at NLP is to be dismantled and new Floatation Pile type Sump Caisson is to be installed. Vendor to submit the final calculations for Sump Caissons at SH and NLP for approval.

VARIABLE	S-1800 (ICP)	S-1100 (SHP)	S-5201 (NLP)	S-810 (HRA)
Operating Pressure (kg/cm ² g)	ATM	ATM	ATM	ATM
Operating Temperature (°C)	16-60	14-65	14-65	14-65
Design Pressure (kg/cm ² g)	0.5	Full Water + 1 kscg	0.5	0.5
Design Temperature (°C)	75	70	70	75
Design Capacity	1524 mm x 61850 mm	Sizing to be done by contractor	1524 mm x 54800 mm	Sizing to be done by contractor
Flow Rate from Open Deck Drain & Skimmer Vessel	11200 BWPD	12000 BWPD	23000 BWPD	15000 BWPD
Water from PWC/Degasser	160,000 BWPD	140,000 BWPD	145,500 BWPD	100,000 BWPD
Inlet Oil Conc.	500 PPM	500 PPM	500 PPM	500 PPM
Outlet Oil Conc. (ppm)	25	25	25	25
Residence time (minutes)	20	20	20	20

Following design conditions shall be used for designing of blow case:

VARIABLE	V-1820 (ICP)	V-1100 (SHP)	V-5211 (NLP)	V-820 (HRA)
Operating Pressure (kg/cm ² g)	3.0	3.0	3.0	3.0
Operating Temperature (°C)	16-74	25-60	16-74	16-74



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Engineering Services
ISO – 9001:2008

PIPING DESIGN CRITERIA

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Prepared / Revised By	Reviewed By	Approved By	Total No. of Pages	Date	Rev. No.
PS	GJ	CBS	15	23.08.11	4

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REVISION STATUS RECORD

PS	GJ	JSS	18	2006	3
BLS	MP	JSS	17	2004	2
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PREPARED / REVISED BY	REVIEWED BY	APPROVED BY	TOTAL No. OF PAGES	DATE	REV. No.



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1. SCOPE OF THIS DOCUMENT

1.1 INTRODUCTION

This outlines to the minimum and mandatory requirements of designs activities for piping, piping components, piping specialties including piping within battery limits of various skids/ package/ modules etc. These criteria shall be read in conjunction with project specifications (as per clause 2. of this specification) attached elsewhere in the bid package.

All piping assemblies, specialties & materials supplied or installed under these specifications shall be in accordance with sound engineering principles. Any omission from this specification shall not relieve the contractor from his responsibility of furnishing equipment or materials to meet the specific process parameters, environmental parameters, safety parameters and any other applicable statutory laws or relevant codes & standards.

1.2 APPLICATION OF THIS DOCUMENT

This document applies to this project for the Company. This document shall not be used for any other purpose.

2. STANDARDS & SPECIFICATIONS

2.1 PROJECT SPECIFICATIONS

1. Piping Design (spec. 2004-A)
2. Piping Fabrication (spec. 2004-B)
3. Piping Material Specification (Spec. 2008)
4. Piping Specialties (spec. 2004-D)
5. Protective Coatings (spec. 2005)
6. Piping & Equipment Insulation (spec. 2006)
7. Welding & NDT (spec. 2009F)


2.2 CODES & STANDARDS

The latest codes shall be used.


1. ASME B1.20.1 Pipe threads

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2.	ASME B16.5	Pipe flanges and flanged fittings		
3.	ASME B16.9	Factory made wrought steel butt-welding fittings		
4.	ASME B16.10	Face-to-face & end-to-end dimensions of valves		
5.	ASME B16.11	Forged fittings (socket welding and threaded)		
6.	ASME B16.20	Metallic Gaskets for pipe flanges: Ring joint spiral wound and jacketed.		
7.	ASME B16.21	Non-metallic flat gaskets for pipe flanges		
8.	ASME B16.25	Butt welding ends		
9.	ASME B16.34	Valves- flanged, threaded & welding ends		
10.	ASME B31.3	Process piping		
11.	ASME B31.4	Pipe line transportation systems for liquid hydro carbons and other liquids.		
12.	ASME B31.8	Gas transmission and distribution piping system		
13.	ASME B36.10 M	Welded and seamless wrought steel pipe		
14.	ASME B36.19 M	Stainless steel pipe		
15.	ASME SEC.VIII	Pressure vessel code		
16.	ASME SEC.IX	Welding and brazing qualifications		
17.	ASTM A105	Specification for forgings. Carbon steel, for piping components		
18.	ASTM A106	Specification for seamless carbon steel pipe for high temperature service		
19.	ASTM A 153	Zinc coating (hot dip) on iron & steel hardware		
20.	ASTM A 182	Specification for forged or rolled alloy steel pipe flanges, forged fittings & valves and parts for high temperature service.		

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21.	ASTM A193	Specification for alloy steel & stainless steel bolting materials for high temperature service.		
22.	ASTM A 194	Specification for carbon & alloy steel nuts for bolts for high pressure & high temperature service		
23.	ASTM A216	Specification for carbon steel casting suitable for fusion welding for high temperature service.		
24.	ASTM A234	Specification for piping fittings of wrought carbon steel & alloy steel for moderate & elevated temperature		
25.	ASTM A262	Recommended practice for detecting susceptibility to inter granular corrosion attack in stainless steels		
26.	ASTM A 312	Specification for seamless & welded austenitic stainless steel pipe		
27.	ASTM A370	Test methods and definitions for mechanical testing of steel products		
28.	ASTM A403	Specification for wrought, austenitic stainless steel, piping fittings		
29.	ASTM A453	Specification for bolting materials high temperature 50 to 120 ksi with expansion coefficient comparable to austenitic steels		
30.	ASTM A578	Straight beam ultrasonic examination of plain & clad steel for special applications.		
31.	ASTM A 694	Std specs. For forgings, carbon and alloy steel for pipe flanges, fittings, valves & parts for high-pressure transmission service		
32.	ASTM A 790	Seamless and welded ferritic/austenitic stainless steel pipe		
33.	ASTM A 799	Std. practice for steel castings, stainless instrument calibration for estimating ferrite content.		
34.	ASTM B42	Std. spec. For seamless copper pipe		
35.	ASTM B 124	Std. spec. For copper and copper alloy forging rod, bar and shapes.		

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36.	ASTM B 165	Std. spec. For nickel copper alloy (UNS4400) seamless pipe and tube		
37.	ASTM B 337	Std. spec. For seamless and welded titanium and titanium alloy pipe		
38.	ASTM B 363	Std. spec. for unalloyed titanium and titanium alloy welding fittings		
39.	ASTM B 366	Std. spec. for factory made wrought nickel and nickel alloy welding fittings.		
40.	ASTM B 423	Std. specs. for nickel-iron-chromium-molybdenum copper alloy (UNS no.8825&8221) seamless pipe and tube		
41.	ASTM B 425	Std. spec. for NI-FE-CR-MO- CU alloy (UNS no. 8825 & 8221) rod & bar.		
42.	ASTM B466	Std spec. for seamless copper nickel pipe and tube		
43.	ASTM D 1785	Spec. for poly vinyl chloride (PVC) plastic pipe		
44.	ASTM D 2665	Spec. for poly vinyl chloride (PVC) plastic drain, waste and vent pipe fittings		
45.	ASTM E18	Rockwell hardness testing of metallic materials		
46.	ASTM E 45	Determining inclusion content of steel		
47.	ASTM E 92	Vickers hardness of metallic materials		
48.	ASTM B 142	Controlling quality of radiographic testing		
49.	ASTM E 165	Liquid penetrant inspection method		
50.	ASTM E 709	Recommended practice for magnetic particle examination.		
51.	API 5 L	Line pipe Specification		
52.	API 6A	Wellhead and Christmas tree Equipment		
53.	API 6D / ISO 14313	Petroleum and natural gas industries-Pipeline Transportation		

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system –Pipeline valves

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|-----|---------------------|---|
| 54. | API 6FA | Fire test for valves |
| 55. | API RP 14C | Analysis, design, installation testing for basic surface safety system |
| 56. | API RP 14E | Design and installation of offshore production platform piping system |
| 57. | API RP 14G | Fire prevention and control on open type offshore production platform. |
| 58. | API 598 | Valve inspection and testing |
| 59. | API 600 / ISO 10434 | Steel gate valves, flanged and butt-welded ends (nps 1 through nps 24) |
| 60. | API 607 | Fire test for soft-seated Quarter turned valves |
| 61. | BS 1868 | Spec. for steel check valves (flanged & butt welding ends) for the petroleum petrochemical & allied industries |
| 62. | BS 1873 | Spec. for steel globe and globe stop and check valves (flanged & butt welding ends) for the petroleum, petrochemical & allied industries. |
| 63. | BS EN 1092-3 | Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated Copper Alloy Flanges. |
| 64. | BS EN ISO 17292 | Metal Ball Valve For The Petroleum, Petrochemical And Allied Industries |
| 65. | BS EN ISO 5761 | Steel Gate, Globe & Check valves For DN 100 and Smaller for Petroleum and Natural Gas Industries |
| 66. | BS 5353 | Specification For Steel Plug Valve |
| 67. | BS 6755-2 | Testing Of Valves. Specification for Fire Type-Testing requirements. |
| 68. | MSS SP 44 | MSS Steel Pipe Line Flanges |
| 69. | MSS SP 75 | Spec. For High Test Wrought Butt Welding Fittings |

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| 70. | NACE MR 01-75/
ISO 15156-1/2/3 | Material for use in H ₂ S containing environments in Oil and Gas Production.
Part-1: General principles for Selection of Cracking resistant Materials.
Part-2: Cracking resistant Carbon and Low Carbon Steels, and the use of Cast irons.
Part-3: Cracking resistant CRAs (Corrosion Resistant alloys) and other alloys. |
| 71. | NACE TM-01-77 | Laboratory-Testing Of Metals For Resistance To Sulfide Stress Cracking and stress corrosion cracking in H ₂ S Environments. |
| 72. | NACE-TM-02-84 | Evaluation Of Pipeline and pressure vessel steels for Resistance To Hydrogen induced Cracking |
| 73. | NFPA-Volume-6 | National Fire Code For Sprinklers, Fire Pumps And Water Tanks |
| 74. | NFPA Volume 8 | National Fire Code For Portable And Manual Fire Control Equipment. |
| 75. | NFPA 15 | Standard for Water spray fixed systems for fire protection. |
| 76 | ASTM D 2996 | Specifications For Filament Wound Reinforced Thermosetting Pipes & Fittings. |
| 77 | ASTM D 2992 | Method For Obtaining Hydrostatic Design Basis For Reinforced Thermosetting Resin Pipes & Fittings. |
| 78 | ASTM A 815 | Specification for wrought ferritic, ferritic/austenitic and martensitic stainless steel piping fittings. |
| 79 | ASTM G 36 | Performing stress corrosion-cracking tests in a boiler magnesium chloride |
| 80 | ASTM G 48A/B | Standard Test Method For Pitting & Crevice Corrosion Resistance of Stainless Steel & Related Alloy By Use Of Ferritic Chloride Solution |
| 81 | ASME B16.24 | Cast Copper Alloy Pipe Flanges and flanged fittings – Classes 150, |

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300, 400, 600, 900, 1500 and 2500.

- | | | |
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| 82 | ASME B 16.18 | Cast Copper Alloy Solder Joint Pressure Fittings |
| 83 | MSS-SP-80 | Bronze Gate, Globe, Angle and Check Valve |
| 84 | MSS-SP-97 | Integrally reinforced forged branch outlet Fittings-Socket Welding, Threaded and Butt Welding Ends |

2.3 ORDER OF PRECEDENCE

In case of conflict the order of precedence shall be as follows:

1. P&ID
2. Data Sheets
3. This Specification
4. Other referenced project specifications
5. Codes and Standards

3. ENVIRONMENTAL DESIGN CRITERIA AND UTILITIES

3.1 BASIC CLIMATIC CONDITIONS

Refer Structural design criteria Section 3.4, Vol- II, attached in bid package.

3.2 SEISMIC AND TRANSPORTATION LOADS

All equipment supports and braces, pipe supports and other support steel work, including temporary braces, shall be designed to withstand seismic loads applicable to the present location. Refer to the Structural Basis of Design for seismic design considerations.

All equipment supports and braces, pipe supports and other support steel work, including temporary braces, shall be designed to withstand the operating, lifting, transport (by road and by sea) and hydro-test loads specified in Project Specification.

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3.3 DESIGN LIFE

The process facilities design life requirement is 25 years.

3.4 DIMENSIONS

SI units shall be used. Dimensions shall be in mm and be related to the Platform datum's or reference lines.

4. DESIGN REQUIREMENTS

All materials shall conform to project Specification and the identified API, ASME, ASTM, BS and NACE codes and Standards.

Design and fabrication shall conform to this Specification and ASME B31.3, API RP14E. In case, any other applicable codes are proposed/ referred the same shall be complied with sufficient information/justification after approval by company.

Ingress of sand particle is envisaged in well fluid and injection water services. Therefore, the valves in well fluid and water injection systems shall be metal seated. Trim of the metal seated valves as a minimum shall be Tungsten Carbide coated.

From piping of pig-barrel of Launcher/Receiver up to piping-pipeline interface shall be designed as a minimum to ASME B 31.4 and ASME B 31.8.

For smooth pigging operation, attempts shall be made to keep the ID of the piping from reducer of pig-Barrel to pipeline –piping interface as close as possible to the ID of the riser in splash zone.

In case, ID of the topside is more than the ID of the riser, thickness of the topside piping shall be increased to match the ID's

If the ID of the topside piping is less than that of riser in splash zone, thickness of the topside piping may be adjusted to match the ID's by:

- Considering the actual design conditions of the line in place of class conditions for pipe wall thickness calculations.
 - Reducing the corrosion allowance for topside piping but not less than the internal corrosion allowance in corresponding pipeline.
- In case, the difference in ID's still exists, ID of the topside piping shall be checked for the passage of gauge plate with out interference. The gauge plate Diameter shall be calculated by the formula given in the 'specification of submarine pipelines'.

All cupro-nickel piping as a minimum shall be supplied in 16-bar system.



Velocity in Cu-Ni piping shall not exceed 1.6 m/sec for 2" NB and below and 3.3 m/sec. for 3" NB and above.

Fluid velocities in copper piping shall not exceed 1.5 m/sec.

Design of Cu-Ni piping system shall be such as to avoid excessive turbulence in the system.

Monel shall be used at locations such as bends, reducers, downstream of restriction orifices, downstream of control valves, downstream of check valves, etc. wherever there may be a possibility of Flow velocities exceeding the limits given above, Impingement of flow stream on piping, or Excessive turbulence.

In all cases where Monel is used it shall be in the form of spool pieces with electrical isolation with Cu-Ni material for minimizing galvanic corrosion of Cu-Ni piping.

Wherever dissimilar metals are in contact, insulating gasket or sacrificial spool piece of 600 mm shall be provided to avoid galvanic corrosion.

Piping general arrangement drawings/isometrics/support drawings etc. shall be prepared using good engineering practices and as per guidelines furnished in project Specifications.

As good engineering practices, piping carrying hydrocarbon and toxic/hazardous chemicals passing through safe area shall be of continuous lengths with welded joints such that valves, regulators, flanges etc. are not located in the safe area.

Thermal Insulation shall be provided wherever required during detail Engineering, and General Specification 2006. Also, wherever necessary, acoustic insulation shall be provided to limit the piping emitted noise to the permissible values as per API standards.

Piping schedule/thickness shall be calculated for each size, service & piping class including corrosion allowance indicated in material of construction of piping specification as per ASME B-31.3 for various services based on piping class conditions upto class 900 & actual design conditions for 1500 class of the system. The same shall be submitted to the Company for review & approval.

The piping connected to equipment shall be analyzed by the Contractor for flexibility and maximum stresses developed, along with nozzle reaction on equipment, and these shall not exceed the permissible limits/values as specified in relevant codes & standards. Vendor data for maximum permissible nozzle loadings shall be obtained while analyzing piping for flexibility analysis. The above permissible limits shall not be exceeded in any case. The analysis shall be furnished to the Company for review & approval.



Piping shall be suitably supported, as necessary, to prevent sagging, mechanical stresses and vibrations. In general, piping shall be fastened to pipe racks with appropriate sizes hot dip galvanized or cadmium plated U bolts {3/8" (9.5 mm) minimum} and shall be double nutted.

The layout of equipment and piping shall be based on following principles:-

- a) To locate all equipments identified on equipment list.
- b) To comply with codes & standards, regulations, P&ID's, project specifications and sound engineering industrial practices.
- c) To maximize safety of personnel, equipment and facilities.
- d) To ensure operability & maintainability of equipment with a provision of adequate clearances all around in horizontal & vertical direction.
- e) To provide means of escape & access for fire fighting.
- f) To satisfy all requirements indicated in process documents.
- g) To minimize shutdown duration.
- h) To provide neat and economical layout, allowing for easy supporting and adequate flexibility to meet equipment allowable nozzle load.
- i) To comply with the requirements of Area classification.

5. FLEXIBILITY ANALYSIS CRITERIA & GENERAL GUIDELINES

Flexibility analysis shall be carried out as per requirements of ASME B 31.3. In addition to the requirements stated in ASME B31.3, following considerations shall be taken care during flexibility analysis:-

5.1 Stress analysis is carried out to prevent the following:-

- a) Failure of pipe work or support from over stress or fatigue.
- b) Detrimental stresses or distortion in pipe work or in connected equipment resulting from excessive thrusts and moments in the pipe work.
- c) Excessive vibration in pipe work.



d) Leakage at joints.

5.2

The following guidelines shall be used to determine the type and extent of analysis to be adopted. The guidelines are not exhaustive and do not replace good judgment and experience particularly with regard to safety aspects of the design.

- a) Process pipe work 3" diameter and larger connected to centrifugal compressors or turbines.
- b) Pipe work connected to other strain sensitive equipment.
- c) 4" diameter and larger at 200°C design temperature and above.
- d) 2" diameter and larger at 300°C design temperature and above.
- e) 8" diameter and larger at 150°C design temperature and above.
- f) 16" diameter and larger at 80°C design temperature and above.
- g) 6" diameter and larger at 65°C design temperature and above connected to equipment like
- h) air coolers, fin fan coolers, fired heaters / furnaces or any other sensitive equipment.
- i) Lines subject to vibration, e.g. Reciprocating compressors and turbines.
- j) Pipe work larger than 3" diameter at -50°C design temperature and below.
- k) Large diameter piping between closely spaced equipment.
- l) All suction and discharge lines connected to pump.
- m) All lines connected to wellhead.
- n) All GRE, PVC, CPVC piping.
- o) If applicable, all high pressure flange joints (i.e. 900# and above) shall be checked for leakage at flange joints due to combined effect of induced bending moments and internal pressure. This check shall also be performed for all lines ≥ 24 " NB irrespective of rating.



p) All lines shall be analyzed at design / operating temperature range.

5.3 All the piping on the bridge between two platforms shall be designed taking into account the differential movements of the two structures under extreme storm conditions (Refer table – 5 of section 3.4 structural design criteria, Volume -II). Flexibility analysis of the piping system shall be carried out wherever required by the design conditions / platform movements and provide necessary loops / supporting arrangement.

6. FIRE SUPPRESSION SYSTEM

Fire Suppression system shall consists of a deluge type fire water spray network, fire water and foam hose reel, portable dry chemical/CO₂ fire extinguishers and dry chemical skid with hose reels.

A deluge type water spray network shall be designed in accordance with NFPA-15.

For quantity of fire water and foam hose reel refer Mechanical design criteria. The location and length of the hose reel shall be suitable to cover all points on the deck.



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3.4.1 Introduction

Design criteria as used herein include all operational requirements and environmental data which could affect the detailed design of the platform. The design methods described herein shall be followed for design and detail engineering. Contractor's design methods shall only be applicable wherever methods not available in this design criteria. Structural design criteria described herein establishes the minimum requirements of design of fixed offshore platform as per the codes and standards listed here in. This Design Criteria has been prepared as a guide and to be followed during Detailed Engineering for the Platform Project(s) or any other project wherever applicable as per scope.


3.4.2 Scope


The scope of this document includes design philosophy and design parameters for design of fixed offshore platforms. The scope also includes design philosophy of modification jobs, special structures and riser clamps, conductor guides, conductors, riser protector, conductor protector, bridges etc. Environmental parameters, design loads, load combinations, permissible deflections etc. are included in the annexures. Design philosophy and parameters which are not included in this document then API RP 2A and other codes and standards listed in this document shall be applicable. Contractor's design methods shall only be applicable wherever methods not available in this document with the approval of the company.

3.4.3 Definitions and Terms:-

Table-1

Sr. No	Term	Definition
1	Fixed offshore platforms	A platform extending above and supported by the sea bed by means of piling with the intended purpose of remaining stationary over an extended period. It includes both substructure and superstructure
2	Substructure	The substructure consists of Jacket and foundation systems (Piling system) including Jacket appurtenance. Generally Deck stabbing point considered as top of the substructure
3	Superstructure	The term superstructure applies to the structural parts of the topsides facilities including decks, buildings module, helideck, module support frames and skids etc. All Structural framing of Decks including Deck legs, trusses and Crane pedestal etcetera are the main components of superstructure. The superstructure generally supports on Deck Stabbing points to transfer topside loads to substructure.
4	Topside	The term topside of a platform includes superstructure and equipment including all other facilities place on superstructure. Normally topside of a platform start at work point and ends at top of the topside.

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5	In-service	Platform in-service design conditions are those, which pertain to the post installation phase of the platform life, and typically include in-place, earthquake, dynamics and fatigue considerations.		
6	Pre-service	Design conditions those occur prior to platform operation and shall generally include load out, transportation and installation considerations.		
7	Global load conditions	those considered in the analysis and design of the substructure, superstructure trusses and legs and module frames		
8	Local load conditions	those considered in the analysis and design of plating, grating, beams, appurtenances and other individual members as applicable		
9	Nominal weight of structure	excludes mill tolerances, inaccuracies, contingencies and tolerances due to weight growth		
10	Datum weight of a structure	nominal weight increased to allow for mill tolerances, inaccuracies, contingencies and tolerances for weight growth		
11	Splash Zone (only for corrosion allowance)	EL (-) 2.00 metre to TOS of jacket walkway.		
12	Splash Zone (for marine growth)	EL(-) 2.00 metre to EL(+) 6.00 metre		
13	Splash Zone (in general including consideration for protective coating)	EL(-) 2.00 metre to EL(+) 6.00 metre		
14	Topside Primary structural member/element	All truss members, deck primary beams/girders, crane pedestal and deck legs, Helideck main framing beams including trusses & Columns, vent/flare booms, etc.		
15	Jacket Primary structural member/element	All main legs, chords, skirt sleeves, vertical/inclined/horizontal and vertical/horizontal diagonal bracing, launch truss (if required), piles, boat landings, riser protector, barge bumper and hanger clamp stubs, hanger clamps, transition pieces, shim plates, conductor framing with Conductor guide/Sleeve.		
16	Topside Secondary structural member/element	deck plate, grating, deck secondary beams, stringers, pipe/E&I/equipment support beams, walkways, ladders & stairs, and hand rails, monorail, access platform, crane boom rest.		

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17	Jacket Secondary structural member/ element	Boat landing secondary members, walkways, riser/ conductor guard, casings, installation aids, appurtenances with their supports, mud mat Plates with Beams and skirt pile guides.			

3.4.4

CODES AND STANDARDS

3.4.4.1

Mandatory Indian Statutory Requirements

This document has been prepared to the International Standards; however, the Contractor shall also ensure that the Work is executed in accordance with all mandatory Indian Statutory and Regulatory requirements

3.4.4.2

Codes Standards & Regulations

The requirements of the latest (except API RP 2A –WSD & AISC) published versions of the listed codes, recommended practices, Specifications and standards given shall be met. All other relevant and related Codes concerning the specific job under consideration and/or referred in the above-mentioned Codes shall be followed wherever applicable. Any conflict between the applicable codes and these Design criteria shall be referred to the Company for resolution. Company's decision in this regard shall be final and binding on the Contractor.

List has been placed at **Annexure-3**.

3.4.5

Basic Information

3.4.5.1

Important constant – Refer Annexure-2.

3.4.5.2

Corrosion Zones

Table 2

	For structural design		For CP Design system	
	From Elevation (M)	To Elevation (M)	From Elevation (M)	To Elevation (M)
Atmospheric Zone	TOS of Jacket walkway	Upwards		
Splash Zone	(-) 2.0	TOS of Jacket walkway	Chart Datum	AT ± + SS #
Submerged Zone	(-) 2.0	Mudline	Chart Datum	Mudline

3.4.5.3

Design Live Loads – Refer Annexure-4

3.4.5.4

System of Units

The SI system of units shall be used throughout the project. All dimensions shall be shown in millimeters and all levels shall be shown in meters.

3.4.5.5

Seabed Feature

The Jackets should be designed for seabed slope and to meet the installation tolerances. If the seabed slope is such as to tilt the Jacket by an angle exceeding 25 minutes, the slope shall be considered in design. Design of the Jacket should also consider mudslide, if any.

The slope in seabed, if any, shall be established by means of a grid survey of bathymetry of a region covering an area 500 meters beyond the footprint of sub-

structure at mud-line using a grid line spacing of 25 meters, before or at the early stage of detailed Engineering. If the slope in seabed is such as to tilt the structure, the detail design shall take into account the slope in seabed in the form of adjustment in framing and/or mud-mat elevations.

3.4.5.6 Platform Configuration

The platform shall be sized and designed in accordance with the approved equipment layout and arrangement. Jacket size at work point level shall be firmed up based on approved equipment layout. Minimum Deck height shall be calculated considering minimum air gap as per API RP 2A. Other Deck height including helideck and building module etc. shall be as per approved equipment layout based on design requirement.

Providing of 'X' braces in between two Jacket horizontal framing in all bays are mandatory for process and LQ platforms. For well head platforms, 'X' braces are not mandatory and same shall be as per design requirement.

3.4.5.7 Chart Datum Level

All elevations shall be referenced to chart datum (0.0M). Chart Datum Shall be 2.51m below MSL. Contractor shall establish Chart Datum as per 3.4.6.1.

3.4.5.8 Platform Location and Orientation

The location and orientation of the platforms shall be as given in DC 3.4 Part – II.

3.4.5.9 Water Depth

The approximate water depths at platform locations are as given in DC 3.4 Part – II. Water Depth at the site of the works may be taken as indicative for preliminary work but the actual water depth shall be determined by Contractor during pre-engineering survey before the commencement of Detailed Engineering. For the design of substructure appurtenances, a provision for the variation of ± 750 mm in the actual water depth shall be considered.

3.4.5.10 Marine Growth Thickness

The design of platforms shall include allowance for marine growth on all members of the jacket including Jacket appurtenances such as risers, caissons, conductors, etc. as per values furnished below:

Table-3

Elevation range (meter)	Marine Growth Thickness for all platforms with Design Life of 25 years (mm)	Marine Growth Thickness for WHPs with Design Life of 15 years (mm)
(+) 6.00 to (-) 2.00	150	100
(-) 2.00 to (-) 30.00	100	100
(-) 30.00 to Mudline	50	50

Note:

- Marine growth shall also be considered for global analysis of boat landing, riser/conductor protector and barge bumper.

3.4.5.11 Geometrical Constraints

- The top horizontal framing of the substructure shall be at minimum (+) 7.60M elevation above chart datum (CD) level, so as not to be in wave splash zone as defined 3.4.2 above.
- Minimum air gap requirement shall be as per API RP 2A for computation of elevation of underside of deck. For this purpose still water level shall be CD + LAT + 100% AT + SS.
- Wave forces on equipment piping, platform components placed below the Cellar/ lowest deck shall be accounted for as per API RP 2A.

3.4.5.12 Deck Heights

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

3.4.5.13 Corrosion Protection

All structures shall be designed to resist corrosion in different zones defined in the 3.4.5.2 in the following manner for the design life of the structures:

3.4.5.13.1 Corrosion Allowance


Additional external wall thickness (over and above the thickness required as per in-service structural analyses) shall be provided as corrosion allowance for structural members and other components only in splash zone. However, in submerged and atmospheric zone such corrosion allowance shall not be applicable. Splash zone for corrosion allowance shall be (-) 2 meter to TOS of Jacket Walkway level and corrosion allowance shall be as tabulated below:


Table-4


Location	All platforms with Design Life of 25 years (mm) (values are in mm)	WHP having Design life of 15 years (values are in mm)
All jacket Primary structural members.	13	8
All jacket secondary structural members of walkway level.	6	4
Barge Bumper, Boat Landing, Riser/Conductor Protector, Conductor guides, Mooring Chains, Pump casings & Sump Caissons, I-Tube/J-tube.	6	4


NOTE:


- An additional internal corrosion allowance of 3mm shall be provided for the full length of Caissons, pumps casings.


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<p>2. Internal corrosion allowance of 3 mm shall be applied to the I-Tube/J-Tube wall thickness for the full length of I-Tube/J-Tube and bell mouth.</p> <p>3.4.5.13.2 Cathodic protection All Steel surfaces considering bare in the submerged zone and splash zone shall be protected against corrosion by a sacrificial anode system. The design conditions pertaining to cathodic protection system are given in Spec. FS 4001. Contractor shall submit the design/ analysis of anode and anode location drawings to the company for approval. At initial stage of engineering, anode location/ position drawings shall be submitted along with jacket framing structural drawings.</p> <p>3.4.5.13.3 Painting In addition to corrosion protection specified in Para 3.4.5.13.1 and 3.4.5.13.2, all steel surfaces in the splash zone and atmospheric zone, including conductors, shall be painted in accordance with Spec. No. 2005 “Protective Coatings”. All equipment, stairways and appurtenances such as barge bumpers, boat landings, riser protectors, and conductors at splash zone, etc. including their stabbing guides shall be painted irrespective of the applicable zone.</p> <p>3.4.5.13.4 Structural Detailing Areas and joints, which are inaccessible for maintenance and thereby susceptible to corrosion due to ingress of moisture causing crevice-corrosion, shall be suitably sealed by methods such as boxing with plates, etc. and design consideration as per ISO 12944-3.</p> <p>3.4.5.14 Miscellaneous Accessories Three identification boards, with name of the platforms shall be provided on North and South faces of the platforms and on the top of the helideck respectively. The details to be written on the boards shall be approved by the Company. The letters on the boards shall be at least 900 mm in size.</p> <p>3.4.6 Pre-Engineering Survey 3.4.6.1 For New Platform Prior to proceeding with detailed engineering Contractor shall perform a pre-engineering survey to confirm water depth, to ascertain seabed feature & properties topsoil for mud-mat analysis, existing platform location and orientation, tubular sizes on existing jacket for riser clamp installation, identification of space facilities under modification scope of exiting platforms and space for bridge landing. Obstructions, if any, found for installation of facilities under scope of work shall also be recorded in pre-engineering survey and to be resolved with technically feasible solution. During Pre-Engineering Survey Contractor shall establish Chart Datum (CD) as per International Practice and Indian Spring Low Water (ISLW) with correlation between ISLW & CD.</p>				


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<p>3.4.6.2 For Modification/ revamping works Contractor shall carry out pre-engineering survey of all Decks/ Jacket walkway/ boat landing areas/, etc. for collection of all necessary information regarding replacement of damaged/corroded Plating/ Grating/ Handrails/ supporting structural members/ Barge bumpers/ boat fenders/, etc. as per project specific scope.</p> <p>3.4.7 Design Philosophy The fixed offshore platform structure shall be designed for stability, integrity, structural adequacy and total safety both in Global and local analysis condition. In-service and pre-service design analysis for Platforms structure for adequacy check of each and every component of the platform structure. All the design analysis shall be carried out based on various loads and load combination defined in this document for extreme and operating environmental storm conditions. All structural analyses shall be performed using a suitable computer program applicable to the design of offshore structures. Mathematical model or Geometry of the platform structure shall be developed suite to specific site condition for design and analysis using suitable computer program. Structural analysis and design of topside, sub-structures, conductors, etc. shall be in accordance with the requirements of API RP 2A, AISC and other relevant codes & standards using working stress design methods. Jacket legs shall be designed as flooded member up-to the Designed Water depth. Pile shall be grouted with the jacket legs and or Skirt Sleeve. Foundation design analysis to be carried out along with Jacket in-place analysis. All pre-service analysis shall also be carried out based on approved installation philosophy. The extent of all the analyses shall be to demonstrate the adequacy of the structural components of the structures under all envisaged forces and anticipated loads at various phases. Analyses shall include but not limited to as stated below:</p> <p>3.4.7.1 In-service condition analysis</p> <p>3.4.7.1.1 In-place design analysis for Jacket (with piles). 3.4.7.1.2 In-place design analysis Topsides (Decks with Modules). 3.4.7.1.3 In-Place design analysis of Modules. 3.4.7.1.4 In-Place design analysis for Helideck. 3.4.7.1.5 In-Place design analysis of Jacket Appurtenances. 3.4.7.1.6 In-Place design analysis of Bridge. 3.4.7.1.7 In-Place design analysis of Deck appurtenance if any. 3.4.7.1.8 In-Place analysis of Special structures (Caisson etc.). 3.4.7.1.9 In-Place design analysis for piles Foundation. 3.4.7.1.10 Fatigue design analysis for Jacket & Pile only. 3.4.7.1.11 Seismic and Dynamic analysis. 3.4.7.1.12 FE analysis as per clause 3.4.16.4.22 for connection between Jacket Leg to Skirt Pile sleeve.</p> <p>3.4.7.2 Pre-service condition analysis</p> <p>3.4.7.2.1 Pile-drivability design analysis.</p>				

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3.4.7.2.2	Conductor drivability design analysis.			
3.4.7.2.3	Lift design analysis at yard for all lift units of platforms.			
3.4.7.2.4	Lift design analysis at offshore for installation all lift units of platforms.			
3.4.7.2.5	Load out design analyses for all components of platforms.			
3.4.7.2.6	Transportation design analysis including sea fastening design for all units of platforms.			
3.4.7.2.7	Jacket lift design analysis at offshore for Installation.			
3.4.7.2.8	Jacket floatation and upending design analysis for Installation.			
3.4.7.2.9	Jacket launch design analysis for installation as applicable.			
3.4.7.2.10	Deck lift design analysis at offshore for Installation.			
3.4.7.2.11	Module lift design analysis at offshore for installation.			
3.4.7.2.12	Helideck lift design analysis at offshore for Installation.			
3.4.7.2.13	Lift design analysis at offshore for installation for appurtenances.			
3.4.7.2.14	Topside Float over design analysis for Installation as applicable.			
<p>Design Philosophy of Deck extension and modification works shall be based on this document and project specific requirement mentioned in structural design criteria part-II. The loads and load combination for design analysis shall be applicable as stated in this document.</p>				
3.4.8	<p>Load Combinations</p> <p>The minimum load combinations as stated at Annexure-7 shall be considered in the Analysis for Design of the Platform structures. For other local and Global design analyses which have not been covered under this design criteria, the CONTRACTOR shall develop the necessary basic load cases and load combinations appropriate to the structure in accordance to respective specific International codes/ standards or Industry standard practice.</p>			
3.4.9	<p>Permissible Stresses and Factor of Safety</p>			
3.4.9.1	Unless otherwise noted in this design criteria permissible stresses and factors of safety shall be as recommended in API RP 2A and AISC.			
3.4.9.2	Increase in Permissible Stresses shall be allowed as stated at Annexure – 8.			
3.4.10	<p>Load Contingencies, Mill Tolerance and Weld metal</p> <p>The Contractor shall accurately calculate the pre-service and in-service design loads as described in Sections 3.4.13 and 3.4.19 consisting of dead loads, piping and equipment loads (empty and operating), topside modules, utilities and any other loads to which the system will be subjected during fabrication, transportation, installation and operation, etc.</p> <p>A minimum of 3% weight allowance to account for mill tolerance and weld metal shall be applied for all analyses. This allowance shall be added to the estimated substructure and superstructure dead weight.</p> <p>Load contingencies shall be as per Annexure – 9.</p>			
3.4.11	<p>Material</p> <p>All materials shall conform to respective specification given in accordance with Spec. 6001F, General Specification for materials, fabrication & installation of structure.</p>			

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<p>3.4.12 Environmental Parameter Environmental parameters of all fields have been furnished at Annexure – 13.</p> <p>3.4.13 Design Loads The loads described in the following section shall apply to the substructure (Jacket, pile, etc.) and topsides unless specified otherwise.</p> <p>3.4.13.1 In-services condition</p> <p>3.4.13.1.1 Structure Dead Load The structure dead loads shall include the weight of all structural members including deck plate, grating, hand rails, bridge, architectural items, rubber, timber, anodes, etc.</p> <p>3.4.13.1.2 Equipment Load Equipment loads shall include the weight of all equipment, bulk material, piping, etc. These loads are to be developed based on equipment layouts. Two basic load conditions shall be considered for global design. These are:</p> <ol style="list-style-type: none"> Equipment & Piping Dead Weight Equipment & Piping with Operating Contents Weight <p>For local design, hydrostatic test weights shall be considered, wherever applicable. Other specific equipment loads are as specified at all relevant annexures.</p> <p>3.4.13.1.3 Crane Loads The Contractor shall determine the static and dynamic crane loads and use data provided by the crane manufacturer. The dynamic crane load cases shall consider a range or boom directions to ensure all possible lifting scenarios are adequately checked. A minimum of eight boom directions shall be considered.</p> <p>3.4.13.1.4 Live Loads for Local and Global Design The magnitudes of local and global live loads to be used in the in-service analysis and design shall be as defined in Annexure-4. For global analysis and design appropriate percentages of the live loads given for local beam design in Annexure-4 shall be used as specified in respective load combination tables given at Annexure-7.</p> <p>3.4.13.1.5 Open Area Live Load Open Area live Load as indicated at Annexure-4 as applicable, shall be used as specified in respective load combination tables given at Annexure-7. The Open Area Live Loads which shall be applied to all clear unoccupied areas of deck and internal areas of the Utility and Equipment rooms. The Open Area live loads shall be used in conjunction with equipment and crane loads for the design of primary and major secondary steel members. Open Area Live Loads should be combined with</p>				

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<p>equipment weight data. Equipment weight as indicated in weight control report or as provided by the Equipment Vendor shall be taken.</p> <p>3.4.13.1.6 Wind Load</p> <p>Wind loads shall be calculated according to the requirements of API RP 2A. The wind area for global design of the Topsides shall be calculated assuming that the area between the decks is fully enclosed. Wind area(s) shall also include the equipment located other than above enclosed deck area. Design wind speeds are as detailed at Annexure-13.</p> <ol style="list-style-type: none"> A minimum of eight or twelve storm directions, depending on the configuration of jacket structure, shall be considered for each load case for the extreme storm and operating storm conditions. For unsymmetrical platforms or structures with skirt piles, the calculation of the environmental forces from additional directions may also be required as per API RP 2A. Wind shall be assumed to act simultaneously and collinearly with wave and current forces. Wind speeds should be adjusted for elevation and gust duration, in accordance with API RP 2A or as listed at Annexure-5. <p>3.4.13.1.7 Wave & Current Loads</p> <p>Environmental parameters as defined in Annexure-13 shall be applied to maximize loading on all structural components. Analysis shall be performed for wave approach along grid directions and selected diagonal directions. For each direction of approach, the more severe of the environmental parameters of directions adjacent to it shall be selected from Annexure-13. A minimum of eight or twelve storm directions, depending on the configuration of jacket structure, shall be considered for each load case for the extreme storm and operating storm conditions as per API RP 2A. Waves and current shall be considered concurrent with wind. The design wave shall be treated as a regular wave. 'Stokes' Fifth Order theory' shall be used to compute water particle kinematics, using apparent wave period computed as per API RP 2A. Wave kinematics factor as given in Annexure-13 shall be used to account for wave directional spreading or irregularity in wave profile shape.</p> <p>The current speed in the vicinity of the platform shall be reduced by the current blockage factors. The wave particle kinematics multiplied by the wave kinematics factor and the current velocities adjusted for blockage, shall be added vectorially to obtain total velocity vector at any point. The given current profile shall be treated as applicable to water depth equal to still water level. For any other water level at different points along the wave, the velocities shall be calculated based on linear stretching of the current profile. Morison's equation applied to only the normal components of velocity and acceleration shall be used to compute normal wave forces on the individual members. The coefficients of drag and mass (inertia) C_d and C_m values shall be considered as per API RP 2A (i.e. 0.65 and 1.6 respectively for smooth surface and 1.05 and 1.2 respectively for rough surfaces).</p>				

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	<p>Conductor shielding factors shall be considered as per API RP 2A. At initial stage of engineering upto approval of drawing stage,</p> <p>a. For Process/LQ platforms, anode effects shall be calculated by increasing Cd & Cm value by 15% on all items in submerged zone</p> <p>b. For wellhead platforms, anode effects shall be calculated by increasing Cd & Cm value by 8% on all items in submerged zone.</p> <p>The increase of Cd/Cm shall not be applicable to members in the splash zone since no anode is provided in this zone.</p> <p>Final stage of Engineering In-place Analysis Anode effects shall be incorporated with calculated Cd & Cm values with respect to structural members. Trapezoidal Anode Cd value of 2.2 and Cm value of 2.51 considering equivalent square section.</p> <p>3.4.13.1.8 Earthquake Loads</p> <p>The earthquake loading on the combined Jacket and super structure shall be calculated using the response spectrum method and in accordance with the provisions of API RP 2A. The response spectrum data for this analysis shall follow the guidelines for Zone-IV (western offshore) & Zone III (Eastern offshore) earthquake area as given in Indian Standards IS-1893. The importance factor shall be taken as 2.0 and response spectra Type III to be considered to account for the soil foundation system. Contribution of the marine growth in the added mass shall be considered in the analysis. For building /equipment/ modules an equivalent static analysis shall be carried out with a horizontal seismic coefficient of 0.12.</p> <p>Earthquake Forces, wherever applicable, shall be taken as occurring in both orthogonal horizontal directions and 50% in the vertical direction.</p> <p>For the earthquake condition, Still Water Level shall be taken as CD + (LAT) + (50% of Astronomical Tide).</p> <p>3.4.13.1.9 Fatigue Loadings has been described at 3.4.14.</p> <p>3.4.13.1.10 Vortex Induced Vibration</p> <p>Slender members of Deck, Vent Boom and Flare Tower, bridge, Helideck supports & framing members shall be checked for VIV for wind for in-service Condition & Transportation condition.</p> <p>Slender members of Jacket shall be checked for VIV for current (in-service condition) and wind for Transportation condition.</p> <p>3.4.13.1.11 Wave Slam</p> <p>Structural members in the wave zone shall be designed for wave slam forces in accordance with API RP 2A. Bending stresses due to both horizontal and vertical slam forces shall be considered. One-third increase in permissible stress shall be allowed. However, the current velocity components should not be included in the wave kinematics when calculating wave slam loading. For X-braces, members shall be assumed to span the full length. Member lengths shall be reduced to account for Jacket leg ratio. The slam coefficient shall be taken as 5.5.</p>			

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<p>3.4.13.1.12 Special Loads: Special load other than load specified in this document are specified in the DC 3.4 Part – II (if any) shall also be considered. Accidental load shall be considered as per API RP2A as applicable</p> <p>3.4.13.2 Pre-service condition Following Pre-service loads are to be considered for design:</p> <p>3.4.13.2.1 Load(s) to be considered for Load-out analysis of Substructure and Topside The proposed method of load out shall be determined by the Contractor and could be by means of continuous or discrete skids, wheel trolleys or by direct lifting. The following should be considered.</p> <p> a) All dead and equipment loads together with weights for all preinstalled lifting gear, sea-fastenings, loose ship items, etc. should be considered. The loads should be based on the Weight Control Report.</p> <p> b) For lifted Load out, refer to the criteria described in section 3.4.13.2.3.</p> <p> c) Skidded or trolleyed load out: Structures shall be loaded out onto the transportation barge by means of launch ways, continuous or discrete skids, and wheeled dollies. The structures shall be checked for adequacy for the proposed load out operation and for the effects of the localized loadings resulting from change in slope of launch ways/tracks and the change in draft of the transportation barge as the structure moves on to it. The analysis for substructure to be loaded out on launch cradle shall cover the front end of launch cradle unsupported for various distances (barge moves downward), and two ends of the launch trusses supported (barge moves upward). For structures loaded out on discrete skids or wheeled dollies, the analysis shall cover cases due to loss of support of one or more supports, including three point support conditions. For other means of load out the analysis shall be based on the support conditions likely to be experienced. If the support conditions envisaged during weighting of the deck/module are different from those considered for load out analysis, a separate analysis shall be performed with appropriate support conditions to ensure adequacy of the structure during weighing operations.</p> <p> d) Bearing capacity of soil in fabrication yard shall be forwarded to design Consultant and taken into account in the analysis.</p> <p>3.4.13.2.2 Load(s) to be considered for Transportation analysis Substructure and Topside A. Preliminary transportation Analysis:-</p>				

All structures shall be checked for the inertia loads during sea transportation. Consideration shall be given to the support points used for sea fastening. The following should be considered.

- Dead and equipment loads should be considered together with weights for all preinstalled lifting gear, sea fastening, loose ship items, etc. The loads should be based on the Weight Control Report.
- For the preliminary transportation condition, pending a detailed transportation and barge motions analysis, the following inertia loads in addition to gravity load shall be considered.

Table-5

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

* 20% shall be added to the loadings resulting from pitch motions for small vessels to cover the effect of slamming.

- The transportation inertia loads shall be combined as:
 $\pm \text{Roll} \pm \text{Heave} + W \text{ (Self Weight)}$ [Beam Sea]
 $\pm \text{Pitch} \pm \text{Heave} + W \text{ (Self Weight)}$ [Head Sea]
 $\pm 0.8 \text{ Pitch} \pm 0.6 \text{ Roll} \pm \text{Heave} + W \text{ (Self Weight)}$ [Quartering Seas]
 $\pm 0.6 \text{ Pitch} \pm 0.8 \text{ Roll} \pm \text{Heave} + W \text{ (Self Weight)}$ [Quartering Seas]
- The effect of wind load in addition to the above need not be considered.

B. Detailed Transportation Analysis


The design of all structures shall accommodate the forces imposed during transportation. The computer analysis shall be performed in accordance with the ABS or any other International Certification Agency rules along with the provisions given therein.


The final transportation analysis shall consist of the following:


I. Static Stability of barge/structure system:


- Intact condition
- 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

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<p>Intact and Damaged conditions respectively. Wind forces shall be calculated as per ABS Rules.</p> <p>The following barge stability criteria shall be satisfied.</p> <ol style="list-style-type: none"> The positive range of stability (ignoring strength or down flooding consideration) shall be in the range of 30°-40°. The righting energy available to resist capsizing shall be at least 1.4 times the energy required by the designed wind to heel the vessel to the same critical angle. <p>II. Dynamic motion response analysis for barge/structure system:</p> <p>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 the following phases:</p> <ol style="list-style-type: none"> Determination of fundamental periods of Roll, Pitch, Heave, Yaw, Surge and Sway motions. Response of the system for various sea states. (Ref.: Ocean Wave Statistics” by N. Hogben and P.E. Lumb) <p>The following shall be considered for the route specific dynamic motion analysis:</p> <ol style="list-style-type: none"> Wave direction: Beam, Head and Quartering Seas. The maximum sea state to be considered shall depend upon route of tow and season of tow. <p>The environmental conditions to be considered shall be based on an average recurrence period of not less than ten years for the season of year when the tow will take place.</p> <ol style="list-style-type: none"> In order to obtain the maximum acceleration response, at least three sets of periods shall be chosen for the maximum sea state for each direction of approach depending upon the dynamic characteristics of the barge/structure system and the towing speed of barge. A reduced wave height (less than the maximum)/period combination, if that is likely to result in near resonant response conditions. <p>After obtaining the maximum response for various sea states, the structure shall be again analyzed for the corresponding maximum inertia/gravity forces.</p> <p>Based on the above analysis, the Contractor shall be responsible for the design of sea fastening and the preparation of detailed sea fastening drawings.</p> <p>Contractor shall also be responsible for verifying the strength of the cargo/launch barge deck and framing system to satisfactorily withstand the loads on it during load out and transportation. Any reinforcement to the barge deck or modification to the sea fastening/ load out arrangement to make the cargo barge safe for the operations is Contractor’s responsibility. All engineering related to load out and transportation shall be subject to approval by a Marine Warranty Surveyor (MWS) as described in Spec.</p>				

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<p>6001F. Copy of approved procedure shall be made available to the COMPANY 30 days in advance prior to load out.</p> <p>3.4.13.2.3 Lift Operations: Substructure (Jacket, pile etc.) and Topside</p> <p>All structures shall be checked for the loads applied during lift operations in accordance with API RP 2A. The following shall be considered.</p> <ul style="list-style-type: none"> c) Dead and equipment loads should be considered together with weights for all preinstalled lifting gear, sea-fastenings, loose ship items, etc. The loads should be based on the Weight Control Report. d) A dynamic factor of 2.0 shall be applied to the lift weight of the item for the design of lifting frames, pad/lifting eyes and adjacent members supporting the pad/lifting eyes. e) A dynamic factor of 1.35 shall be applied to the lift weight for all other members transmitting lifting forces. f) Where a four sling arrangement is used to lift the item, the analysis shall be carried out in two cases, first assuming all slings equally effective i.e. each diagonal carries 50% of the static lift weight and second with one diagonal sling carry 75% and the other diagonal sling carry 25% of the static lift weight. The dynamic factor for lifting pad eye design for second case i.e. for sling carrying 75%-25% static lift weight shall be 1.35. g) Rigging shall be designed to limit the swing of the lifted objects within 2 degrees from horizontal about any axis. Static equilibrium during the lifting operation shall be ensured. h) Structural deflections shall be limited for deflection sensitive equipment, buildings and other items as per Section 3.4.16.1.3. i) For lift operation under marine environment, environmental condition for installation as in DC 3.4 Part – II shall be followed. <p>A complete three-dimensional idealized mathematical model of the structure shall be analyzed for the stresses developed during lifting operation to comply with the provisions of API RP-2A.</p> <p>The bidder to provide list of major lifts as envisaged by him in the format furnished in DC 3.4 Part – II along with the marine spread proposed for installation.</p> <p>During Detail Engineering the contractor shall perform a lift study to establish that the modules as conceived are lift-able with the proposed barge crane. This study shall include adverse combinations of variation in centre of gravity / weight. The lifting scheme including requirements of spreader frame shall be finalized based on this study. The weight control report generated shall form the basis of the study. A three-dimensional space frame lift analysis shall be performed for all structures to be lifted. The load combination shall include appropriate skew load distribution between the two diagonal pair of slings to account for sling length variation.</p> <p>If the subsequent weight control reports / actual weighing of the module indicate a weight increase of more than 5% and / or a shift in centre of gravity of more than 2% of the corresponding linear dimension, a revised</p>				

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		<p>lift analysis shall be carried out to ensure that the permissible stress are not exceeded due to the revised weight / centre of gravity. The analysis shall also be repeated if the framing arrangements of lifting scheme, spreader frame arrangement or components to be lifted are revised to an extent to affect the stress distribution in the structure.</p>		
3.4.13.2.4	Other Installation Loads All structures and structural components shall be checked for all of the loads likely to be imposed during all phases of the installation. The imposed loads shall be appropriate to the method of installation.			
3.4.13.2.5	Stab-in Guides and Installation Aids All stab-in guides and bumpers shall be designed for the following loads, as a minimum: 1. Horizontal impact force = 10% of the static weight of the item. 2. Vertical impact force = 50% of the static weight of the item.			
3.4.13.2.6	Fabrication Loads All structural components shall be checked for the loads applied during fabrication. The CONTRACTOR shall determine details of the loads and the structure support points. Consideration shall be given to the support points used for weighing and load out. Wind loads shall be included with this load condition, appropriate for the site location.			
3.4.13.2.7	Floatation and Upending Flotation and Upending analyses is to investigate the stability, bottom clearance, derrick vessel hook loads and buoyancy requirements at successive stages of the Jacket installation.			
3.4.13.2.8	Jacket launch analysis Jacket launch analysis is a three dimensional launch simulation analysis for determining the jacket stability, bottom clearance and barge-jacket behavior.			
3.4.13.2.9	Deck float over analysis Deck float-over method is one of the deck installation method with single barge.			
3.4.14	JACKET FATIGUE DESIGN			
3.4.14.1	General The tubular joints of the Jackets shall be analyzed for fatigue endurance in accordance with API RP 2A. For simplified fatigue analysis, a recalibration has been recommended based on changed tubular joint S-N curve and recommended SCF formulations. This is applicable for L-3 type platforms with natural periods less than 3 seconds constructed of notch-tough ductile steels and having redundant inspectable structural framing except first under water horizontal framing and horizontal framing near to mud line connected with mudmat.			

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A detailed fatigue analysis should be performed for all other type of structures. A spectral analysis technique shall be used to properly account for the actual distribution of wave energy over the entire frequency range.

Fatigue on account of inline thickness transition shall be carried out for Jacket. Fatigue Analysis for Pile shall be carried out both for In-service Condition and Pre-Service Condition. Pile wall thickness shall be selected such that Pile driving fatigue is minimized and the Pile meets the in-service Fatigue design Life with the factor of safety.

CONTRACTOR shall develop an appropriate fatigue analysis methodology and procedure to include wave selection, estimating stress concentration factors, fatigue S-N curves etc. and submit to the COMPANY for approval.

Further to analysis and design of tubular and non-tubular joints, the methods for weld improvement techniques and such other viable techniques may be resorted to improve the fatigue life.

Corrosion allowances as defined at clause 3.4.5.13.1 shall be halved for fatigue analysis.

3.4.14.2 Fatigue Life

The in-service Fatigue Life Safety Factors of the joints shall be as detailed below:
Table-6

Type of Platform	Fatigue Life Safety Factor	
	Jacket 2nd Level (1st under water Horizontal Framing upto splash Zone) & Mudline Horizontal framing & Piles in Mudline region	All other Levels of Jacket under water and Jacket walkway level primary to primary joints
Process & LQ	10	5
Well Head	5	2

Note: - 1. Design Fatigue life of Structure = (Fatigue Life Safety Factor) x (Design Life of Structure).

3.4.14.3 Loading

i) The environmental parameters to be used for computing the wave loading in the fatigue analysis shall be as given in DC 3.4 Part – II. All required input environmental data shall be generated from the supplied information and shall be used for the analysis after getting the same approved by the company.


The annual wave exceedance data for four orthogonal directions shall be as given in Annexure-13.


ii) Still water depth for fatigue analysis shall be taken as CD + SS + (LAT) + 50% AT. Data for SS, LAT & AT are provided in Annexure-13.


iii) Wave forces shall be computed in accordance with the procedure described in Section 3.4.7.7. Kinematics factors as 1.0, Conductor Shielding Factor 1.0 and hydrodynamic co-efficient as detailed below:


Table-7


- iv) Eight Wave Directions shall be considered for Fatigue Analysis. Each direction minimum ten wave height shall be used to compute Stress Range.
- v) Ninety phase angle in each wave shall be used to determine maximum & minimum base shear.
- vi) Stress range calculation shall be carried out at eight position of each wave. Out of eight positions one position is at maximum base shear, another position is at minimum base shear. Remaining positions shall be selected at equal interval between Maximum & Minimum Base Shear positions.
- vii) For Well Platform: The Marine Growth thickness shall be as per Table no. 3 at 3.4.5.10.


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	<p>In lieu of more accurate procedure for analysis these may be checked for simple joints but using modified chord thickness. The effect of ring stiffeners is twofold:</p> <ol style="list-style-type: none"> An increase in area of the chord, which may be accounted for by calculating the area of the chord shell plus stiffener and from this the effective shell thickness, which by itself will give the same area. An increase in the stiffness of the chord which may be accounted for by calculating the moment of inertia of the chord shell plus stiffener and from this the effective shell thickness, which by itself would give the same moment of inertia. <p>For external ring-stiffened joints, a minimum stress concentration factor shall be used in Brace members as per API-RP-2A. Minimum SCF of 6.0 shall be used for externally ring stiffened joints. Refer API RP 2A for SCF of internal ring stiffened joint.</p> <ol style="list-style-type: none"> iv. Overlap Joints: Overlap Joints shall be eliminated for construction of new Platform. v. Gusset Plate Stiffened Joints: Gusset Plate Stiffened Joints shall be avoided for construction of new Platform. vi. Stress Concentration Factor for inline thickness Transition for Tubular Joints and for misalignment of tubular shall be calculated in line with DNV C 203 code. vii. SCF for Yoke Plate connection to Jacket & skirt Leg, Shear Plate connection between Jacket Leg, Skirt Leg & Yoke Plate shall be worked out through FE Analysis wherever such connections are applicable. <p>3.4.14.6 S.N. Curves S-N curves in compliance to API RP 2A WJT / WJ Curve (without applying weld improvement technique) shall be used in the evaluation of fatigue life, which shall be achieved during Pile configuration stage. S-N Curve as per DNV C203 for Sea water with Cathodic Protection shall be complied to determine fatigue Life for:</p> <ol style="list-style-type: none"> Inline thickness Transition for thickened Joint CANs, Yoke Plate connection to Jacket & skirt Leg, Shear Plate connection between Jacket Leg, Skirt Leg & Yoke Plate wherever such connections are applicable, Pile fatigue: Design fatigue life listed in Table under Clause No. 3.4.14.2 shall be followed for the respective zones. Offshore version for Pile Drivability Analysis shall be used to calculate Pile fatigue. <p>3.4.14.7 Marking of Joints Deleted</p> <p>3.4.15 FOUNDATION DESIGN 3.4.15.1 Soil Data The soil investigation reports of all the platform locations are included as indicated at DC 3.4 Part – II.</p>			


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<p>3.4.15.2 Foundation Type CONTRACTOR shall design the foundation system, appropriate to the structures and soil conditions that meet the requirements of API RP 2A. 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. The minimum Factor of Safety (FOS) for a pile foundation shall be 2.0 under operating storms and 1.5 under extreme storm as stipulated in API RP 2A. In cases where Piles are terminated in Sand Layer, Underlain by clay layer, pile tip shall have minimum clearance of 3 pile diameter above the bottom of Sand Layer. Pile Self Weight and Soil Plug shall be accounted for computation of Pile Factor of Safety. Company shall provide relevant geotechnical data for any particular pile size required during detailed engineering.</p> <p>3.4.15.3 Scour The minimum scour depth around Jacket leg/piling shall be the greater of: - a) 1.5 times the pile diameter, or b) The depth computed/stated in approved geotechnical reports. For Scour depths more than 2 X Dia. of pile, global analysis shall be carried out.</p> <p>3.4.15.4 Under-drive and Overdrive Allowance A minimum Overdrive of 3 meter for LQ/Process platforms and 1.5 meter for wellhead platforms shall be considered to account for soil lateral variation. The pile wall thickness make-up shall be designed to allow for the possibility of pile driving refusal prior to design penetration and overdrive beyond design penetration. The minimum under drive and over drive allowance shall be submitted to COMPANY for approval.</p> <p>3.4.15.5 Pile Group Effect Consideration should be given to the effects of closely spaced adjacent piles on the load and deflection characteristics of pile groups. Generally, for pile spacing less than eight diameters, group effects have to be evaluated. Minimum spacing (center to center) of any two pile shall be 3 times the larger pile diameter. Pile Group Axial Capacity Piles embedded in clays, the group capacity may be less than a single isolated pile capacity multiplied by the number of piles in the group; conversely, for piles embedded in sands the group capacity may be higher than the sum of the capacities in the isolated piles. The Pile Group Axial capacity shall be calculated using H. G. Poulos & E. H. Davis Method. Pile Group Settlement The group settlement in either clay or sand would normally be larger than that of a single pile subjected to the average pile load of the group. Pile Lateral Behaviour For piles with the same pile head fixity conditions and embedded in either cohesive or cohesion-less soils, the pile group would normally experience greater lateral deflection than that of a single pile under the average pile load of the corresponding group. The major factors influencing the group deflections and load</p>				


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<p>distribution among the piles are the pile spacing, the ratio of pile penetration to the diameter, the pile flexibility relative to the soil, the dimensions of the group, and the variations in the shear strength and stiffness modulus of the soil with depth. Following methods to be the most appropriate for use in designing group pile foundations for the given loading conditions:</p> <p>The Focht-Koch (1973) method [1] as modified by Reese et al. (1984) [2] for defining group deflections and average maximum pile moments for design event loads. Deflections are probably under-predicted at loads giving deflections of 20% or more of the diameter of the individual piles in the group.</p> <p>Reference:</p> <ol style="list-style-type: none"> 1. FOCHT, J. A. and Koch K. H (1973), Rational Analysis of the Lateral Performance of Offshore Pile Groups, Proceedings from the 5th Annual Offshore Technology Conference, OTC 1896, Houston, Texas, April/May, 1973. 2. REESE et al. (1984), Analysis of a Pile Group under Lateral Loading, Laterally Loaded Deep Foundations: Analysis and Performance, ASTM, STP 835, pp. 56–71. <p>3.4.15.6 Shear Keys</p> <p>Shear keys on piles and the pile sleeves shall be provided. Shear keys shall be designed in accordance with API RP 2A and with the following considerations:</p> <ol style="list-style-type: none"> a) Load transfer should be considered only through the length over which the shear keys of both pile and leg/sleeve, of jacket, overlap including under drive/overdrive conditions. b) Design strength of grout shall be taken as 17.25 Mpa whereas the actual grout strength during installation shall not be less than as specified in Spec. 6001 F. c) Shear key shall be continuous hoop type and uniformly spaced. d) Skirt sleeve Shear key length at mudline zone shall not be considered for shear key design calculation. This length shall be minimum of (i) two meter from mudline or (ii) one times diameter of pile from mudline. Similarly top one meter of Skirt sleeve shall not be considered for shear key design calculation. <p>3.4.15.7 Pile Installation</p> <ol style="list-style-type: none"> a) Drivability Drivability Analysis shall be carried out for Hammers designated for Driving. Also the Drivability Analysis shall be carried out for Hammers to be used for Refusal Mitigation. During detail Engineering Pile shall be designed both for (a) Hammer Designated for Driving and (b) Hammer designated for Refusal mitigation. <ol style="list-style-type: none"> i) Hammer Designated for Driving Based on preliminary drivability studies the bidder to list set of hammers proposed to be mobilized by them (Refer DC 3.4 Part – II) to drive the piles proposed in their conceptual design to the design penetration. During detail engineering the Contractor shall perform a detail pile drivability analysis using stress wave equation procedure to ensure that the piles as proposed in his design are 				


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<p>drivable to the design penetration with the hammers as listed in DC 3.4 Part – II. The Contractor shall also design the pile wall thickness requirements and add-on lengths of the piles from drivability, dynamic and static stress considerations.</p> <p>For this purpose the analysis shall be done for each type of pile and for each combination of pile/add-on geometry and hammer at discrete penetrations for the full length of each pile. The pile shall be checked with its tip both plugged and unplugged for a range of hammer size with range of Pile minimum Wall thickness for continuous driving & for set up for small duration for pile segment add-on. Both Lower and Upper bound drivability Analysis shall be carried out for Plugged & unplugged driving.</p> <p>In order to make the pile drivability smooth, Pile impedance needs to be increased. This will facilitate mobilization of lesser capacity Hammer. Lesser the pile impedance, higher is the driving stress and higher the Pile driving Fatigue. Therefore, Pile D/T Ratio of Pile shall be planned less than 60.</p> <p>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).</p> <p>Maximum 90% hammer efficiency shall be considered during pile drivability analysis for sizing of Hammer.</p> <p>Plugged Driving: External Skin friction is active + Pile full Cross-section area is active for Bearing.</p> <p>Un-Plugged Driving: Pile External Wall Skin friction is active + Pile Internal Wall skin friction is active + Pile annulus area is active for Bearing.</p> <p>ii) Hammer designated for Refusal mitigation (Refer clause 5.6 of part II of volume I of bidding documents).</p> <p>Both Lower and Upper bound drivability Analysis shall be carried out for Plugged & unplugged driving with soil set-up condition.</p> <p>iii) Conductor Driving</p> <p>Contractor shall also perform a detail drivability analysis in line with point i) above (read with note- 5 at Table-II of Annexure-10 and conductor wall thickness given as one inch) for the conductors to ensure the conductors are drivable to the design penetration using Hammers specified in Structural Design Criteria, Section 3.4 Part – II of Bid .</p> <p>OTC Paper 3274 relates to Pile driving experience of Mumbai Offshore. OTC Paper 4205 may be referred regarding consideration of internal friction and general guideline for reference.</p> <p>b) Pile Section Length</p> <p>Pile section lengths shall be selected in accordance with API RP 2A. Consideration shall also be given to the Contractor's proposed marine spread and the allowable stick-up length for the hammers to be used. The</p>				


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<p>pile make-up shall be planned to avoid pile add-ons when the pile tip is nearer than 3.0m from a stratum where hard driving is expected.</p> <p>c) Pile Run Down Evaluation The Contractor shall perform the pile run down evaluation under the following conditions as a minimum requirement. Contractor may also employ any other method suitable to the pertinent soil condition to estimate pile run down.</p> <ol style="list-style-type: none"> When soil resistance to driving (SRD) is less than the static weight of pile and or pile plus hammer. When total work done by the pile against soil resistance is less than the potential energy lost by the pile due to free drop When blow count during initial driving is less than two blows per 30 cm <p>Drivability Analysis of Conductor shall be similar to that of Piles (with consideration outlined vide Note- 5 at Table-II of Annexure-10 and conductor wall thickness given as one inch).</p> <p>d) Pile monitoring System with restrike Test: Bidder shall deploy dynamic pile monitoring system during installation of piles at offshore for all piles (main and/or Skirt) for monitoring the energy transfer to the piles and efficiency of hammer & driving system as well as the pile stresses. Pile monitoring system shall have valid calibration. Adequate standby arrangement for pile monitoring tools & Systems shall be made available at the barge. A procedure for pile monitoring shall be submitted to the company for review. Refer Spec 6001F for Re-strike Test & further details.</p> <p>3.4.15.8 Soil Disturbance Disturbed soil conditions upon withdrawal of jack-up rig shall be considered for the front row piles of well platforms. Disturbed zone shall be equal to the full depth of the estimated jack-up rig footing penetration. The estimated jack-up rig footing penetration shall be as given in DC 3.4 Part – II. The sensitivity of the soil in the disturbed zone shall be as given in the soil report. The Contractor shall generate all necessary data for use in the analysis.</p> <p>3.4.16 DESIGN PROCEDURES 3.4.16.1 Design Requirements 3.4.16.1.1 General</p> <ol style="list-style-type: none"> Structural design shall conform to the relevant codes listed under clause no- 3.4.2 of DC-3.4 part-I, in particular API RP 2A and AISC, and other relevant standards and codes. Structural design shall be based on working stress design Where code checks are not applicable, allowable stresses shall be computed using rational procedures and appropriate factors of safety. Major rolled shapes shall be compact sections as defined by AISC. The minimum thickness of structural plates and web of rolled sections as defined by AISC should not be less than 6mm. 				


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<p>f) The minimum thickness of flanges of rolled sections as defined by AISC should not be less than 6mm for secondary member and 10 mm primary members.</p> <p>g) Deck floor plate shall be chequered type with a raised pattern surface and the minimum thickness should be 8 mm. and deck plating on building module shall be minimum 6 mm. Slope of 1:100 shall be provided at roof top of building module. Deck plating thickness in lay down area shall be minimum 10mm.</p> <p>h) The minimum thickness of Jacket tubular should be 12 mm except in the splash zone where minimum thickness shall be: 12 mm + applicable corrosion allowance as per clause 3.4.5.13.1.</p> <p>i) The minimum thickness of deck truss tubular should be 8 mm.</p> <p>j) Spacing of secondary beams supporting Clear span of plating should not exceed 1200mm. Plates shall be reinforced if concentrated loads are directly placed on plating.</p> <p>k) Clear span of grating should not exceed 750mm. Gap between two adjacent gratings which are not supported on beams/tubular shall not be more than 10mm. Gap between two adjacent gratings which are supported on beams/tubular shall not be more than 25mm.</p> <p>l) Vibration should be considered for any structure supporting major rotating machinery. The structure shall be designed in such a way that the natural frequency of the supporting structure is less than 70% or greater than 140% of the equipment operating frequency. Contractor shall demonstrate this aspect suitably, wherever applicable, during detailed engineering.</p> <p>m) Member stresses due to aspects which are not specifically covered in the computer structural analysis shall be investigated by manual calculations and results combined with computer results to ensure that the stress and deflection limitations are not exceeded.</p> <p>n) All major structural members shall meet the following guidelines:</p> <ol style="list-style-type: none"> 1. Slenderness ratio ($K*L/r$) of Diagonal Member of Vertical framing shall be limited to 80 and $(F_y*D)/(E*t) \leq 0.069$ for all platforms. Slenderness ratio ($K*L/r$) of other members are ≤ 100. The buckling coefficient K shall be chosen for each member in accordance with API RP 2A recommendation. 2. Member slenderness ratio: $K l/r \leq 100$. The buckling coefficient K shall be chosen for each member in accordance with API RP 2A recommendations. 3. Rolled tubular member diameter to thickness (D/t) ratio: $20 < D/t < 60$. 4. Diameter to thickness (D/t) ratio of Un-grouted Jacket Legs shall not exceed 50. Alternately Piles are grouted to the Jacket Leg for the full length of Leg. 5. In case of concentric tubular for jacket grouted legs with piles the: D/T for tubular for jacket legs shall be ≤ 100. 6. For grouted joints the effective thickness shall be calculated using root mean square formula and limited to 1.75 times outer shell thickness. 				


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<p>o) Use of sections back-to-back, battened and lattice type built up sections shall not be permitted, in order to avoid areas difficult for maintenance.</p> <p>p) Adequate access for inspection, surveillance, maintenance and repair shall be provided as per ISO 12944-3.</p> <p>q) The clear gap between conductor and conductor guide shall be minimum 50mm.</p> <p>3.4.16.1.2 Connections</p> <p>I. <u>Welded Connections</u></p> <p>Basic design philosophy is the member should fail first than joint in compliance to API RP 2A. All connections shall be designed as welded joints. The joints required for removable type structural members shall be considered as bolted joints as approved by the COMPANY during detailed engineering.</p> <p>a) Tubular Joints</p> <p>Tubular joint design and detailing for both pre-service and in-service conditions shall be in accordance with API RP 2A and shall be designed and detailed as simple joints as per API RP 2A. Overlapped Joint shall not be provided for New Platform construction.</p> <p>b) Non-Tubular Joints (Hybrid joints)</p> <p>i) Beam to tubular column connection</p> <p>Combining rolled wide flange sections with tubular sections as used in module trusses, plate girder or wide flange joints shall be designed in accordance with AISC and API RP 2A using rational engineering methods considering leg/column as through member with Ring Stiffener (External and or internal). The joint shall be designed for full capacity of connecting Beam Flange. Joint shall also be checked for Maximum Loads under Pre-Service Analysis</p> <p>ii) Truss joint connection between tubular brace and beam</p> <p>Truss brace to chord joints shall be designed for transfer of axial loads from one brace to another across the truss chord in shear. The stiffeners shall be designed to carry in compression the permissible axial tensile load of the brace.</p> <p>c) Ring Stiffened Joints</p> <p>Appropriate closed ring solutions shall be used to design launch leg ring stiffeners at deck leg/girder intersections as per the provisions of API RP 2A. Such external ring stiffeners shall not be applicable to other tubular to tubular Joints. At Deck Leg(s) / Girder intersection (s) and at Deck / Module lifting Points, external ring and or internal stiffeners may be provided. Design shall be based on Roark's ring formula in combination of AISC guidelines. Full capacity of Beam flange shall be used for design calculation and critical position of Pre-service Analysis. Full penetration weld shall be provided between Tubular and Ring stiffener.</p> <p>d) Cross joints, Launch leg joints and other joints in which the load is transferred across the chord shall be designed assuming an effective width of the chord equal to 1.25 times chord diameter, on each side from the centerline of the extreme incoming brace(s) or length of the can whichever is less.</p> <p>e) Inter coaster Beam Connection: All primary beam of equal depth shall have inter-coaster connection with full penetration weld between web to web and flange to flange. In case of Primary Beam connection for unequal depth have</p>				


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<p>inter-coaster connection with full penetration weld between web to web, flange to flange (top) and Flange to web. Web having full penetration weld from both side, such web shall be provided with steel having through thickness property.</p> <p>f) The connection of top flange of secondary beam with top flange of primary beam shall be full penetration weld. The connection of web and bottom flange of secondary beam with web of primary beam shall be fillet weld from both sides. The bottom flanges of secondary beams shall not be sniped.</p> <p>g) The connection of stiffeners with flanges of beams shall be full penetration weld & with webs of beam shall be fillet weld from both sides.</p> <p>h) A drain hole minimum 30mm shall be provided at the bottom of stiffener for drainage of water.</p> <p>II. Bolted Connection Bolts specified in Spec 6001F or any other document shall be designed as per AISC guideline.</p> <p>Bolt Design in Atmospheric Zone: Bolted connection at the atmospheric Zone shall be designed as non-slip Bolt. Minimum pretension value shall be applied in complied to AISC and pre-tension value shall be specified in the drawing so that same is applied during installation.</p> <p>Bolt Design in splash zone and submerged zone: Bolted connections are applicable for supporting Riser, I-Tube or J-Tube. Bolted connection in splash zone and submerged zone shall be designed for both non-slip bolted joint and Slip Critical bolted joint. In this zone Bolt shall experience cyclic load on account of wave, which shall create fatigue in bolts. Bolts design does not require Fatigue analysis provided Bolt UC ratio are maintain below 0.8. Designed bolt Pre Tension value shall be derived from maximum of Pre Tension calculation (Torsion, Transverse Shear (combined with torsion), Longitudinal Shear, Pull-off, Effect of member axial stress with Factor of Safety for frictional resistance of 1.5) and Radial Contact Pressure as applicable (Longitudinal Moment, Transverse Shear, Pull –off & Effects of Axial Member Stress with safety factor for Tension due Radial Pressure of 1.2). 20% Bolt relaxation value shall be added with designed pre tension value for Bolt pre tension carried out in one go. Accordingly, 20% gap between bolt full pre tension value & Designed Pre Tension Value shall be maintained. Also minimum pre-tension Criteria need to be met as per AISC. Clamp Flange Plate and connecting stiffeners shall be designed for bolt full capacity. Welding of Flange Plate to stiffener shall be full penetration Weld from both sides. Flange – stiffener compactness shall be checked. Welding between Stiffeners to Clamp Shell shall be partial penetration weld from both sides. Welding between Flange plates to Clamp Shell shall be full penetration weld from both Sides.</p> <p>3.4.16.1.3 Deflections Following Deflection shall be complied for Design of Platform:</p> <p>i. Horizontal/lateral deflection of platform at mudline</p>				


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<p>a. The Horizontal framing deflection under operating storm condition at mudline shall be maximum $D/10$ where D is diameter of pile.</p> <p>ii. Vertical Deflection for Top Side: Deflection shall be limited to criteria & equipment operating requirements specified by equipment suppliers or the following, whichever is less: Deflections shall be checked for the actual equipment live loads and casual area live loads pattern. Deflection shall be within limit as specified at annexure-12.</p> <p>3.4.16.2 Pile Configuration Proposal Pile configuration proposal complying bid specified requirements shall be submitted on frozen of Equipment Layout with following:</p> <ol style="list-style-type: none"> Structural Analysis Model Soft Copy in software format. Cd & Cm value to be increased by 15% for Process/LQ platforms and 8% for Wellhead Platforms to account for anode effect. Pile Force extracts. Pile Factor of Safety Calculation with accounting for self-Weight of pile & weight of Soil Plug. Deflection extract (a) for Pile, (b) at Jacket Leg joints at mudline framing and (c) at Jacket Leg joints at jacket walkway framing. Selection of Pile wall thickness based Hammers (designated for driving & refusal mitigation Hammer) supported with Pile Drivability Analysis (soft copy in soft format). Design shall comply with the consideration like Flooded Legs & Grouted connection between Pile & Jacket Structure (Legs and or Skirt sleeve). On-Bottom Stability Analysis philosophy shall be addressed (regarding use of Stability Tanks and its removal post installation). Extract of Fatigue Analysis Report with SACS Model input Files. <p>NOTE: Pile material shall be ordered after design of Pile wall thickness with respect to Hammer mobilization (Both for Designated & Refusal mitigation Hammer).</p> <p>3.4.16.3 Structural Analysis All structural analysis shall be performed using a suitable structural analysis computer program. The datum for the axes should be the Chart Datum. The modeling techniques used should be appropriate for the structure being analyzed and in conformance with proven industry practice. All analyses shall be performed with the same Computer Program and should utilize the same base model. i.e. the in-place analysis. The in-place analyses shall include a combined Jacket and Topsides model to ensure correct soil- pile stiffness interaction. The Jacket model should consider the effect of environmental loads on the appurtenances including anodes, boat landing, barge bumpers, conductors, risers and riser guard, etc. <u>UC shall be as below:</u> <u>For Well head platforms:</u> All UC ratios of platform structural members, joints and piles shall be as per API RP 2A.</p>				


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<p><u>For Process/LQ platforms:</u> UC ratios of platform structural members, joints and piles shall be restricted to 0.95. Deck Leg and all knee brace members and Joint UC ratio shall be restricted to 0.85.</p> <p><u>For all type of platforms:</u> Deck Leg at knee Brace Joints shall be designed to have 100% Brace Capacity. Strength UC for other joints shall be as per API RP 2A.</p> <p>3.4.16.4 Miscellaneous Design</p> <p>3.4.16.4.1 Deck Plate and Grating Design The local design of deck plating and grating shall be based on the applicable loads defined in applicable annexures of this document. Deflection of plating shall be not greater than the minimum of L/250 and half the thickness of plate. Deflection of grating shall be not greater than L/200. Where “L” is distance between points of supports.</p> <p>3.4.16.4.2 Beam and Plate Girder Design The local design of beams and plate girders shall be based on the applicable loads defined in applicable annexures of this document. These shall be designed in accordance with AISC specification and shall incorporate the following guidelines.</p> <ol style="list-style-type: none"> 1. All plate girders shall be compact sections as defined by AISC. 2. Web, Top and bottom flanges at a given section shall be of the same grade of steel and symmetric about the beam's axes. 3. Deflection shall be limited to the criteria specified in Section 3.4.16.1.3. 4. Welding between flange & web of plate girder/ box girder/ built up girder shall be full penetration weld. <p>3.4.16.4.3 Handrails, Walkways, Stairways and Ladders Handrails, walkways, stairways and ladders shall be designed in Accordance with as specified below:</p> <ol style="list-style-type: none"> i. Handrail <ol style="list-style-type: none"> a) Handrails shall be provided around the perimeter of all open decks and on both sides of stairways. b) Handrails around the perimeter of lay down areas, loading and unloading areas shall be removable type. c) The top rail of the handrail shall be supported at maximum 1500 mm intervals. Height of top rail shall at 1100 mm from plating/grating level. d) For Cellar Deck & Above: Handrails shall be designed to withstand 100 kg concentrated load acting vertically or horizontally at any point. e) Handrails in the wave zone shall also be designed to withstand extreme storm maximum wave loading. f) Clear Gap between two handrail posts shall be maximum 50mm. ii. Walkway, Stair Way 				


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<p>a) Walkways, stairways and landings shall be designed for the following load combinations.</p> <ol style="list-style-type: none"> 1. Dead load + live loads 2. Dead load + extreme storm three second wind gusts and/or extreme storm maximum wave whichever is applicable <p>b) Stairways shall be provided with Tubular stringer beam with plates for supporting the treads. However, Rolled section is also applicable for stairways stringer beam above Cellar Deck. Stair ways shall be provided with grating treads and hand rail (in compliance to Spec 6001F). The minimum clear width of stairways and walkways shall be 1200 mm for process Platform and 750 mm for un-manned /well platform measured between inside of Handrail.</p> <p>c) Walkway and stair tread grating shall be seal welded/fillet welded from all around to structural members to prevent crevice corrosion.</p> <p>d) Stairways in escape routes shall be designed to allow for transportation of injured personnel by use of standard stretchers.</p> <p>e) Stair Treads shall withstand a foot load of 2000 N (200 kg) on an area of 100 mm x 100 mm at any position without permanent deflection.</p> <p>f) All treads shall have a toe plate of minimum 50 mm height. All landings shall have a toe plate of minimum 100 mm height. Openings between toe plate and decks or gratings shall not exceed 10 mm.</p> <p>g) There shall be a maximum of 16 risers in any single stair flight (except Adjustable Stair from Jacket Walkway to Sub-Cellar Deck).</p> <p>h) Nosing shall be provided to the treads of staircase. All nosing shall have a non-slip surface.</p> <p>i) Riser height shall be between 150 mm to 175 mm.</p> <p>j) Maximum Stair angle with horizontal shall be 38°. For adjustable stair maximum slope shall be 45°.</p> <p>k) Width of tread shall be 250 mm minimum excluding nosing/overlap.</p> <p>l) The Projection of Treads shall overlap /nose one another with minimum 20 mm.</p> <p>iii. Vertical Ladder:</p> <p>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.</p> <p>Vertical ladders shall be provided with Cage protection when height of Ladder exceeds 3000 mm.</p> <p>All stairs extending to the substructure walkway level shall be adjustable in length to suit site conditions.</p> <p>Material for handrails, Kick plates, Walkway gratings, Stairways treads and landing area grating shall be of stainless steel as per Spec 6001F, above from boat landing area to below cellar deck level.</p> <p>The inclined ladder shall be at angles of 50 degree to 75 degrees from the horizontal.</p> <p>iv. The Stair in restricted area shall be designed as per OSHA 1917.120 (b) (5) Guidelines. The Stairs shall</p> <ol style="list-style-type: none"> 1. be at angles of 50 degree to 75 degrees from the horizontal 2. be capable of a single concentrated load of 890 N at the tread centers; 				


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<div> <ol style="list-style-type: none"> 3. have open treads with minimum width of 100 mm with rounded edge. 4. have treads shall be uniformly spaced & have vertical rise between treads of 150 mm to 250 mm. 5. handrails on both sides and that are not less than 750 mm in height from the tread surface at the riser face. 6. Have minimum clear width of 600 mm. </div> <div> <p>3.4.16.4.4 Access Platforms Access platforms shall be provided, where required, to allow personnel easy and safe access in elevated locations as per approved equipment layout. Access platforms shall be designed for live loads described in this document and any piping or other imposed loads. Minimum clear height of access platform from top of plating to bottom of beam shall be as specified elsewhere in the bid.</p> </div> <div> <p>3.4.16.4.5 Cranes Pedestals The crane pedestals and the supporting structure shall be designed in accordance with API RP 2A and API SPEC 2C except that the impact factors shall conform to design requirements for the cranes. The supporting structure is defined as the pedestal and all members directly connected to the pedestal. 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. The maximum deflection of loaded condition shall be within limit as specified by the swing bearing manufacturer. The material for pedestal shall meet or exceed the requirements of API Spec 2H Gr.50Z steel (API 2H-50Z). Crane pedestal shall be located in elevation and plan such that the crane operator will have a clear line of vision to the deck of supply boat and to the cargo landing zone on the platform. The fatigue life of crane pedestal and support structure shall be calculated in accordance with API RP 2A for minimum 25000 cycles. Crane boom rest shall be designed for the maximum loads to which they are subjected when the boom is in stowed position and during the cyclonic and seismic environmental conditions.</p> </div> <div> <p>3.4.16.4.6 Fire Walls A firewall / barrier wall with passive fire protection between well head area and process area shall be installed. The fire ratings for the firewall partitions as covered in the scope of the work for walls, ceilings and floors shall be determined by CONTRACTOR following the platform safety case/risk assessment studies. The fire protection system for firewalls shall comply with the specification Passive Fire Protection for Structural steelwork on offshore platforms shall be as detailed elsewhere in the bid document. The requirement to fire protection of the primary structural steelwork and the platform crane pedestal, if specified, should also be determined by the CONTRACTOR following the Platform Safety Case/Risk Assessment studies.</p> </div>				


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<p>3.4.16.4.7 Skid Shoe Design The following should be considered</p> <ol style="list-style-type: none"> The skid shoes should be designed such that the module reaction forces are spread evenly onto the skid rail. The maximum allowable applied load for the skid rail shall be nominated by CONTRACTOR The skid shoes should be designed to meet the dimensional requirements of the skid rails in the construction yard, as established by CONTRACTOR At the tugging points, a safety factor of 2.0 shall be applied to the attachment points and the structure local to the attachment point. Consideration should be given to the effects of any eccentrically applied loads. No increase in basic allowable member stresses is permitted. <p>3.4.16.4.8 Boat Landing Boat landing shall be provided in three stage with minimum elevation difference between any two stages shall be one-meter based on high and low tide variation. Suitable ladder shall be provided. Boat landings associated connections and local framing shall be designed for boat impact loads as specified in this document, environmental loads, uniform live loads and dead loads. For structural design the load shall be treated as a concentrated load. RUBSTRIP ON BOATLANDING VERTICAL FACE: Vertical rub-strips along berthing face of the boat landings shall be provided. Mooring bollards shall be provided near each end of the boat landings for supply vessel mooring. Bollard shall be designed to moor 1000 DWT vessel. Two swing ropes shall be provided near the mid-point of each landing, one at the face of the landing and the other 1 meter seawards of the landing face and about 1 meter apart horizontally. Swing ropes shall be supported from the lower deck structure. Proper arrangements for replacing the swing ropes from topside of the lower deck shall be provided. The boat landing shall be detailed such that there shall be no interference with other items of substructure such as risers, barge bumper etc., during installation operation. In case of boat landing designed to be field installed, it should be detailed to allow a (\pm) 750 mm elevation adjustment to compensate for variation in the installed height of the jacket. The boat landing shall be designed as removable and readily replaceable with stabbing guide on sub-sea support member.</p> <p>The Boat landing and its associated connections and local framing shall be designed for the following load combinations:-</p> <ol style="list-style-type: none"> Dead load + Live Load of 500Kg/m² on each landing Dead Load + Boat impact load at different points on the berthing face Dead Load + Extreme environmental load. Installation Loads. <p>The energy to be absorbed in the Boat landing Structural Frame Work from vessel impact shall be 3.0 tonne meter. Where the boat landing is to act integral with a Barge Bumper system, the requirements of the section 3.4.16.4.9 shall also be considered.</p> <p>Vertical fenders along berthing face of the boat landings shall be provided. Mooring bollards shall be provided near each end of the boat landings for supply vessel mooring. Two swing ropes shall be provided near the midpoint of each</p>				


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<p>landing, one at the face of the landing and the other 1 meter seawards of the landing face and about 1 meter apart horizontally. Swing ropes shall be supported from the lower deck structure. Proper arrangements for replacing the swing ropes shall be provided.</p> <p>The boat landing shall be detailed such that there shall be no interference with other items of substructure such as risers, barge bumpers etc. during installation or operation. Analysis of jacket framing members shall be carried out for the boat impact loads on barge bumper, for this purpose the force equal to the rated load of the shock cell shall be applied at both the shock cell support points.</p> <p>No one-third increases in permissible stress shall be allowed in jacket framing member for this analysis.</p> <p>Tubulars of shock cells shall be designed for environmental loads.</p> <p>3.4.16.4.9 Barge Bumper</p> <p>For structural design the load shall be treated as a concentrated load. Local denting of the vertical post shall be neglected.</p> <p>The barge bumpers shall be designed as removable and readily replaceable with stabbing guide on sub-sea support member.</p> <p>It is permissible to integrate the design of boat landing and barge bumper systems into a single unit with appropriate energy absorption of loads as given in design criteria.</p> <p>Analysis of jacket framing members shall be carried out for the boat impact loads on Barge bumper. For this purpose the force equal to the rated load of the shock cell shall be applied at the shock cell support points. No one third increases in permissible stress shall be allowed in Jacket framing member for this analysis. However, one third increases shall be allowed for a vertical member supporting the barge bumpers / shock cells.</p> <p>The connection of barge bumper with jacket leg shall be as under:</p> <ol style="list-style-type: none"> Top of barge bumper shall be connected with jacket leg using doubler plate. The doubler plate shall be fillet welded to the jacket legs. The stub of shock cell of barge bumper shall be welded to doubler plate with full penetration weld. Bottom of shock cell shall be supported (with stabbing guide) on the horizontal stub clamped to the jacket leg. <p>The mooring chains shall be provided to the barge bumper assembly and tightly secured to the jacket legs with pad-eye & doubler plate to prevent the pull out of the shock shells.</p> <p>The Barge Bumpers and their associated connections to the Jacket shall be designed for the following loading: -</p> <ol style="list-style-type: none"> Vessel impact directly in the middle 1/3 height of post. Energy to be absorbed in the system shall be 30.4 tonne-meter. Vessel impact lateral in the middle 1/3 height of post. Energy to be absorbed in the system shall be 11.0 tonne-meter. <p>Barge Bumpers shall be provided at all legs of Process Platforms to protect jacket legs from ship impact as API RP2A guidelines. In case of Well Platforms, where riser protectors are not provided, the Jacket Legs shall be protected from ship impact as per API RP 2A by providing Barge Bumper in both direction.</p>				


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<p>3.4.16.4.10 Riser Protectors & Riser Protector cum Boat landing All riser protectors & riser protector cum boat landing, as specified in the scope of the work, shall be designed to absorb concentrated impact energy of 100.0 tonne metre (TM) applied at any point on the face. Plastic collapse analysis shall be performed for this purpose. Any point on the deflected structure shall be at least 300 mm clear from any present or future riser. The support of the riser protector, which is welded to the jacket, shall be designed elastically. No increase in basic permissible stresses shall be considered. Riser Protectors & riser protector cum boat landing shall be designed as removable and readily replaceable with stabbing guide/ clamps on Sub Sea supporting members. Riser Protector shall have Vertical members placed @ 2 m interval for entire span with minimum Size 457mm Ø & Horizontal member of minimum 457mm at top and bottom riser protector of Well/process Platform. Forces on account of Riser Protectors shall be considered during detailed engineering of the platforms. Riser protectors shall bear painted signs “DO NOT BERTH.”</p> <p>3.4.16.4.11 Conductor Protector Load for future clamp-on conductor & Conductor protectors shall be considered for Design of Jacket in compliance to Bid scope of work. In case of work related to Clamp on, Conductor Protector shall be designed for following: Conductor Protector shall be designed to absorb minimum concentrated impact energy of 100 tonne meters (TM) applied anywhere on face at any point. Plastic collapse analysis needs to be performed for this purpose. Any point on the deflected structure shall be at least 300 mm clear from any present or future conductor. The support of the conductor protector, which are welded to the jacket shall be designed elastically. No increase in basic permissible stresses shall be considered. Conductor Protectors shall be designed as removable and readily replaceable with stabbing guide on sub-sea support member. This is applicable for new Platform construction. Conductor Protector shall have Vertical members of minimum Size 457mm placed @ 2 m interval for entire span & Top & bottom Horizontal member shall be minimum 457mm Ø. Conductor protectors shall bear painted signs “DO NOT BERTH.” For the purpose of capturing hydrodynamic load center to center of Row-1 of jacket to outermost vertical member of future conductor protector shall be adopted as 3.0 meter. However, for the purpose of fabrication of conductor protector sizing shall as per detailed engineering.</p> <p>3.4.16.4.12 Conductor Guide Framing The support/guide for Curved Conductor shall be designed for elastic bending forces of outer casing conductor and subsequent casing/tubing to be installed inside the outer casing as per detail indicated in DC 3.4 Part – II in combination with extreme storm design environmental conditions. The designs of Conductor guide framing shall also consider the load imposed during and after the installation</p>				


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<p>of conductors. A minimum clear gap of 50mm shall be provided between conductor & conductor guide. As a minimum the following criteria shall be considered for the design of Conductor guide framing:</p> <p>Top Level: Weight of all the Conductors (Straight and Curved) installed in the substructure prior to drilling or 2 time the weight of the Conductor which will initially pass this level, whichever is governing.</p> <p>Second Level: 1.5 times the weight of the Conductor, which will initially pass this level and elastic bending forces due to curved conductor, if any.</p> <p>Subsequent Level: 0.5 times the weight of the Conductor, which will initially pass this level and elastic bending forces due to curved conductor, if any.</p> <p>3.4.16.4.13 Conductors All the Conductors shall be driven to 70 meter penetration below seabed or the point of refusal whichever is earlier. Curved Conductors may be pre-installed in the substructure before the substructure load out. Conductors may be curved or vertical Curvature of curved conductors shall be taken 3° per 30.5 m of arc length. The minimum clearance between any two Conductors shall not be less than 600 mm. below mud line and 150 mm above mud line. In case 600 mm could not be met then in consultation with ONGC Drilling section, the spacing can be revised. Company reserve the right to change the location of Vertical Conductor (VC) to Curved Conductor (CC) or Curved Conductor (CC) to Vertical Conductor (VC) and shall be communicated during early stage of Detail Engineering. In order to avoid clash between Conductor & Structural Member at Platform North side, the first row of Conductor (parallel to Platform North) shall be placed minimum 1500 mm away from Row – 1 of Platform. Conductor clash check (with Conductors to conductor, Conductor to Structural members & Conductor to Piles) shall be carried out for Curved Conductors by the Contractor during detail engineering. Such clash shall be brought out with proposal of interchange of Conductor Positions or by shifting the conductor position to the extent of 800 mm and or increase & decrease in orientation ± 10 degree, etc. and shall be decided in consultation with ONGC Drilling Section. Vacant slots shall have vertical conductors and shall be driven up to 70 M depth below mud line or the point of refusal whichever is earlier. Additional loads due to future clamp-on structure, if any, consisting of deck extensions, conductors and conductor protector shall be considered in design as per the Scope of Work and structural design criteria. At the lower end of conductor a driving shoe having wall thickness 6 mm more than the conductor nominal thickness, having length 500 mm with bevel end shall be installed. Uniform internal diameter of the conductor shall also be maintained.</p> <p>3.4.16.4.14 Design of I-TUBE / J-TUBE I-tube / J-tube shall be designed as a structural member fitted from jacket level hanger clamp to bending level of flexible pipe, to be laid inside of I-tube / J-tube,</p>				


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<p>shall be supported by adequate number of clamps, are also to be designed as structural member as per Structural Design Criteria:</p> <p>i) I-Tube / J-Tube Thickness On firming up of internal diameter of I-Tube / J-Tube during detail engineering, Vortex Induced Vibration (VIV) design spanning studies are carried out to determine the thickness of I-Tube/ J-Tube.</p> <p>ii) Clamp Location of I-Tube/J-Tube I-Tube/ J-Tube shall be supported by Hanger clamp at Jacket Level and other (adequate) clamps suitably placed and supported from Jacket member in sub-sea both for new and existing platform. Number of clamps and their location shall be selected by CONTRACTOR to prevent the I-Tube/ J-Tube from becoming overstressed during design storm conditions. I-Tube / J-Tube shall be capable to withstand storm condition and Vortex Shedding Criteria as per DNV rules. Clamp shall be initially padded with 12 mm thick Neoprene sheet bonded to the clamp steel surface by adhesion. Specification of Neoprene specified in Specification No. 2015. However, Contractor shall submit detail Neoprene sheet fixing procedure for Company's approval. Where adjustable clamps are provided, electrical continuity for Cathodic Protection of clamps shall be provided between Jacket and clamps. All bolting on the I-Tube/J-Tube clamps shall utilize fully tightened, double nuts with washer on each end of the struts. All Nuts, Bolts and washers shall conform to ASTM 193, Gr. B7 and ASTM 194, Gr. 2H. All Nuts, Bolts and washers for subsea clamping the I-Tube/J-Tube shall be XYLAN /PTFE COATED. All nuts & bolts exposed to weather shall be of ASTM A-193 Grade B8M and nuts of ASTM A-194, grade 8M unless otherwise specified in approved drawings.</p> <p>iii) I-Tube/J-Tube is required to be protected by corrosion allowance as per clause no. 3.4.5.13.1 of structural design criteria Part I along with protective coating system 3(b) as per clause 13.2.3 of Specification for Protective Coating 2005 in lieu of 5 mm monel sheathing. The I-Tube/J-Tube below the splash zone required to be protected with cathodic protection as per Clause No. 3.4.5.13.2.</p> <p>I-Tube /J-Tube flexible flow line seal shall be designed to be installed at the end of the bell mouth. The I-Tube/J-Tube hang off clamp shall be designed to allow the addition of corrosion inhibitor and / or Oxygen scavenger inside the I-Tube/J-Tube</p> <p>iv) Hanger Clamps/ Flange All I-Tube/J-Tube shall be provided with suitable hanger clamps/ flange for supporting it. I-Tube/J-Tube hanger flanges shall be designed, manufactured and installed by CONTRACTOR as per relevant codes and standards. Company shall review and approve complete details, design, fabrication and installation of I-Tube/J-Tube.</p> <p>3.4.16.4.15 Equipment Supports</p>				


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<p>All equipment supports, pipe supports and other supports steelwork shall be designed to withstand the operating and hydro-test loads specified on the vendor data/ documents.</p> <p>For transportation condition, in lieu of detail analysis, an equivalent static analysis shall be carried out for following inertia load as minimum:</p> <ol style="list-style-type: none"> 1. Horizontal Acceleration = 0.7 g 2. Vertical acceleration = 0.2g <p>3.4.16.4.16 Helideck</p> <p>The analysis and Design of Heli Deck integrated with the super structure module shall be carried out as per the data and load combinations given at Annexure-11. Helideck shall be designed complying CAP 437 guideline (latest edition). Helideck supports & framing members shall be provided with necessary vortex shedding to avoid vortex induced vibrations.</p> <p>Helideck Analysis Design:-</p> <p>The entire helideck primary trusses and frame shall be analyzed as three dimensional space frame based on the guidelines as indicated below and as per the data and load combinations indicated at Annexure-11.</p> <ol style="list-style-type: none"> a) 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 & Norsok C-004 guidelines unless specified otherwise in the respective discipline specifications. b) Aluminium Helideck shall comply with CAP 437 requirement. All helidecks shall be provided with: <ol style="list-style-type: none"> 1. Friction factor as recommended in CAP 437. 2. Provision of fitment of helideck landing nets (to cater for future requirement of net fitment, if any.). c) Design loads for helideck beams, solar panel platform and firefighting platform shall be as given in relevant annexures in this document. d) Helideck safety net shall slope upwards at 10 degrees with the outer edge level with the flight deck surface. e) 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. In case of solar panel deck is provided below helideck in well head platform/unmanned installations, perimeter walkway shall be provided below helideck with the provision handrails and grating. f) Wind Direction Indicator - A heliport shall be equipped with at least one wind direction indicator. A wind direction indicator shall be constructed so that it gives a clear indication of the direction of the wind and a general indication of the wind speed. A wind direction indicator shall be located so as to indicate the wind conditions over the final approach and take-off area and in such a way as to be free from the effects of air flow disturbances caused by nearby objects or rotor downwash. It shall be visible from a helicopter in flight, in a hover or on the movement area. 				


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<p>An indicator should be a truncated cone made of light weight fabric and should have the following minimum dimensions as per CAP 437 guidelines.</p> <p>The colour of the wind direction indicator should be so selected so as to make it clearly visible and understandable from a height of at least 200 m above the helideck having regard to background. Where practicable, a single colour, preferably white or orange should be used. Where a combination of two colours is required to give adequate conspicuity against changing backgrounds, they should preferably be orange and white, red and white, or black and white, and should be so arranged in five alternative bands, the first and last band being the darker colour.</p> <p>A wind indicator at a heliport intended for use at night shall be illuminated.</p> <p>3.4.16.4.17 Bridge Design</p> <p>The requirements for design of the bridge for in-service conditions are given in this section. The check for pre-service condition shall be same as for super structure.</p> <p>a) Loading</p> <p>The bridges between platforms shall be designed to withstand the appropriate operating loads including piping, monorails, cable and cable trays, live loads and contingencies as per relevant annexures of this document, in combination with wind loads. The bridges shall be designed to be installed using suitable pickup sling arrangement.</p> <p>The following requirements apply to the design criteria for bridges and determination of bridge load for jacket and deck design. For in-place (Operating and Extreme) conditions the piping operating loads computed on the basis of presently planned piping (including any planned future piping) shall be increased by 20% to cater to the possible future needs.</p> <p>The AFC and as-built drawings of bridge landing for both ends of each bridge shall contain a note indicating the maximum bridge reaction for which the bridge landing has been designed for.</p> <p>A live load of 250 Kg/sq.m shall be considered on the bridge walkway. The load combination to be considered for the design of bridges shall be as follows:-</p> <ol style="list-style-type: none"> Dead load of bridge + dead weight of piping, cable and cable trays + piping operating contents weight + extreme storm wind + bridge frictional load. Dead load of bridge + dead weight of piping, cable and cable trays + piping operating contents weight + walkways live load + monorail live load + operating wind load \pm bridge frictional load. Dead load of bridge + dead weight of piping, cable and cable trays. Dead load of bridge + dead weight of piping, cable and cable trays + hydro-test load of any one of the large diameter pipe at a time. Truss Members of bridge shall be checked for Vortex Induced Vibration due to wind for displacement and fatigue damage. <p>b) Support Conditions</p>				


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	<p>The bridge shall be designed to accommodate transverse and longitudinal differential platform movement between the two platforms supporting it. Predicted maximum relative deflection shall be calculated based on a ‘worst’ case condition i.e. the sum of the maximum absolute deflections of the adjacent platforms. One end of the bridge shall be designed as a hinged support and the other end as a sliding support. The sliding support shall provide guide restraints in the vertical and lateral directions. The sliding as well as pinned support shall have a self-lubricating PTFE bearing element ‘FLUOROGOLD’ or approved equivalent. 150% of the total predicted translation shall be allowed for in the end connection and bridge design. The hinged connection shall be designed to withstand 150% of the expected axial thrust. Bridge support shall be capable of accommodating a + 1.0 M tolerance in all direction for final platform location. The requirements for design of the bridge for in-service conditions are given in this section. The check for pre-service condition shall be same as for super structure.</p> <p>c) Deflection The maximum deflection of the bridge due to bridge in operation + live load shall be limited to $L/400$ where ‘L’ is the average distance between bridge support points. The bridge shall be designed to be fabricated with a built-in camber so that it will remain level after installation. Bridge shall be cambered to compensate for dead-load deflection.</p> <p>d) The clear width of walkway on bridge shall be minimum 1.20 m. The width of bridge shall be sufficient enough to accommodate piping/pipelines, cables etc. laid from one end to the other end in addition to walkway on the bridge.</p> <p>e) Bridges connecting process platform shall have Roof covering for weather protection. Slope of roof covering shall be minimum 1:50.</p> <p>3.4.16.4.18 Flare Boom/Tower Flare tower are typically wind sensitive and a detailed assessment of wind loads shall be undertaken. The tower design shall incorporate a means of removing and replacing the flare tip which aims to minimize impact on facility operations. Truss Members of Flare boom/tower shall be checked for Vortex Induced Vibration due to wind for displacement and fatigue damage.</p> <p>3.4.16.4.19 Monorail Design The monorail shall be designed for load lifted, weight of monorail beams, and weight of lifting appliances. The vertical load shall be increased by 25% to account for impact load. For dynamic effect the total maximum static wheel load shall be increased by the following percentages: i) Longitudinal direction: 10% ii) Transverse direction perpendicular to beam: 20%</p> <p>Deflection</p>			


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<p>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.</p> <p>End Stoppers Effective end stoppers shall be provided on the monorail to prevent the trolley either falling from the monorail beams or fouling the structure in which the monorail is installed.</p> <p>3.4.16.4.20 Hydrostatic Collapse</p> <ol style="list-style-type: none"> i. All buoyant member including buoyancy tanks shall be checked for hydrostatic collapse during the pre-service conditions for higher of the two following cases. <ol style="list-style-type: none"> 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. ii. Tubular members shall be checked for in-service condition for hydrostat pressure and in-service stress interaction as per 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. For earthquake condition the factor of safety for axial compression case shall be taken as 1.2. iii. Connection of buoyancy tank with jacket legs shall be designed and checked for Hydrostatic Collapse during launching/lifting of jacket during installation. <p>3.4.16.4.21 Sump Caissons and Pump Casing All Sump Caissons and Pump Casing as a special structure as per API RP 2A. Pump casings in submerged zone shall be protected from corrosion as per NACE Guidelines.</p> <p>3.4.16.4.22 Connection between Jacket Leg to Skirt Pile sleeve The Connection between Skirt piles sleeve to Jacket Leg shall be configured using Yoke Plate & Shear Plate connection. Slotted tubular should be provided for stiffening of shear Plate. Calculation for shear transfer from Skirt Pile to Jacket leg shall be supported. FEA Analysis shall be carried for skirt sleeve connection with jacket legs design in addition to Structural Analysis carried out through Structural Analysis Software irrespective of type of connections. SCF Factor for all welded joints shall also be calculated using FEA Analysis for use in Fatigue analysis. During period of Detail Engineering period, FEA software loaded in Laptop shall be provided at ONGC Office as well as at Design Centre to facilitate review & Approval of Analysis & Drawing. However, Yoke Plate & Shear Plate connection is not mandatory for WHPs. Tubular connections for such cases maybe applicable. However, in case of tubular connection is selected and designed then also, FE analysis shall be mandatory.</p> <p>3.4.16.4.23 Design of SSIV/Wye Valve Protection Cage SSIV/WYE valves assembly shall be provided and installed with protection cages along with CP protection. SSIV/Wye valves cages shall be integrated with pipeline by Clamping arrangement. Contractor shall select one of the following</p>				


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<p>supporting methodologies to support the SSIV/Wye valves and accordingly shall design the Structure with supporting arrangement. The complete SSIV/Wye valves and fittings shall be suitable for operation sub-sea at the water depth and environmental conditions specified and shall be designed and fabricated for a design life of twenty five (25) years. Top protection frame of SSIV/Wye valves shall be designed to withstand the drop object force of 20KJ.</p> <ul style="list-style-type: none"> • SSIV/Wye Valve Protection Cage Supported by Pin Pile. • Increasing the Base weight by Grouting of SSIV/Wye Valve Protection Cage. <p>3.4.16.4.24 Design Drop Object Protection for Top Side Facility The location and loading on drop object protection deck, if any, shall be established by the contractor as per safety studies. However, the protective structure shall be designed for the following as minimum requirement:</p> <ol style="list-style-type: none"> 1. An equivalent static load of 1.5 MT/sq. m over the entire protection area wherein members adequacy is ascertained using allowable stress design concept. 2. Dropped object impact load of 2.0 MT/sq. m of size 2mx2m falling from a height of 3m shall be considered. Ultimate strength analysis (plastic design) shall be used for ascertaining the adequacy of structural members against the dropped object impact load. <p>3.4.16.4.25 Jacket under water Repair Refer Design Criteria 3.4 Part – III – wherever applicable.</p> <p>3.4.16.4.26 Clamp-on Provision on Existing Well Platform: Clamp-on Conductors shall be driven up to 70 M depth below mud line or the point of refusal whichever is earlier. Process Scope of Work shall be referred to ascertain numbers of Conductor. Conductors shall be provided at the outer face of Row – 1 (north side of Row – 1). Conductors may be curved or vertical. Curvature of curved conductors shall be taken 3° per 30.5 m of arc length. The minimum clearance between any two Conductors shall not be less than 600 mm below mud line and 150 mm above mud line. In case 600 mm could not be met then in consultation with ONGC Drilling section, the spacing can be revised. Company reserve the right to change the location of Vertical Conductor (VC) to Curved Conductor (CC) or Curved Conductor (CC) to Vertical Conductor (VC) and shall be communicated during early stage of Detail Engineering. Conductor clash check (with Conductors to conductor, Conductor to Structural members & Conductor to Piles) shall be carried out for Curved Conductors by the Contractor during detail engineering. Such clash shall be brought out with proposal of interchange of Conductor Positions or by shifting the conductor position to the extent of 800 mm and or increase & decrease in orientation ± 10 degree, etc. and shall be decided in consultation with ONGC Drilling Section. Conductor Protector shall be provided with 100 ton-meter energy absorption capacity. Extension at Cellar Deck & Main deck shall be provided by contractor complying the bid requirement specified elsewhere in the bid.</p>				


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3.4.16.4.27 Survival Craft Stations				
<p>Escape to the sea shall be by Totally Enclosed Motor Propelled Survival Craft (TEMPSC), davit launched lifeboats as approved by company.</p>				
<p>Survival craft support structural members shall be designed to support a load factor of 2.2 times the functional loads combined with the design loads specified for survival craft muster areas, in accordance with International Convention for Safety of Life at Sea (SOLAS). In addition, an impact factor of 1.3 shall be applied to the survival craft weight. The functional load defined herein shall include the weight of the survival crafts, blocks and falls and the number of persons the survival craft is deemed fit to carry.</p>				
<p>The weight of each person shall be 75 kg for design purposes. The falls shall be inclined at an angle of 15 degrees to the vertical about two axes.</p>				
3.4.16.4.28 Antenna Mounting Facility				
<p>Suitable walk ways are to be provided to reach antenna locations. The parabolic UHF antenna shall be mounted on 2' NB schedule 80 pipe stand at the end of the walkway. Contractor shall design all antennas mounting facility limiting the direction of the stand.</p>				
3.4.16.4.29 Design of Temporary Members/Props				
<p>Temporary members/props and other aids for loadout and transportation shall be designed and used by the Contractor to ensure that there is no overstressing or damage to any permanent member of structure during load out /transportation operations.</p>				
3.4.16.5 Pre-Service Design/ Analysis				
3.4.16.5.1 Sea fastenings				
<p>CONTRACTOR shall assess the extent of sea fastenings. The design of sea fastenings shall accommodate the anticipated loads during Transportation.</p>				
3.4.16.5.2 Stab-in Guides and Installation Aids				
<p>The following should be considered</p>				
<p>a) The aids should 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.</p>				
<p>b) Any deflections must be within the elastic limit of the material</p>				
<p>c) A 33% increase in allowable member stresses is permitted.</p>				
3.4.16.5.3 Jacket Launch				
<p>Three dimensional launch simulation analysis shall be performed to determine the jacket stability, bottom clearance and barge-jacket behavior during launching operation.</p>				
<p>Three dimensional launch trajectory analyses shall consider the following variation in basic parameters:</p>				
<p>a) Launch Weight (-) 3% to (+) 5% of the weight defined in the Weight Control report</p>				


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	<p>b) Longitudinal Centre of Gravity is offset to 1% of length of jacket towards top of jacket</p> <p>c) Barge Trim is (–) 50% to (+) 50% of the selected trim</p> <p>d) Coefficient of Friction for skid rails is (+) 25% of estimated value</p> <p>e) Higher values of variation in the above parameters may be studied, if so required, by the CONTRACTOR</p> <p>f) Sufficient combinations of the above basic parameters shall be analyzed to produce the worst-case launch scenario.</p> <p>g) A minimum mud line clearance of 10.00 m at both top and bottom of the jacket shall be ensured during the entire launch operation</p> <p>The Jacket member and joint stresses shall be checked for code compliance during all phases of the launch. The rocker beam load distribution shall account for the relative stiffness of the rocker beam and launch leg, and shall satisfy moment equilibrium constraints on the rocker beam.</p> <p>Members with all longitudinal axes, which enter the water within 15 degrees of horizontal, shall be checked for slam effects using predicted velocities from the launch analysis.</p> <p>3.4.16.5.4 Jacket Flotation and Upending</p> <p>Flotation and Upending analyses shall be performed to investigate the stability, bottom clearance, derrick vessel hook loads and buoyancy requirements at successive stages of the Jacket installation. Following points shall also be considered during floating and upending analysis:</p> <p>a) A minimum bottom clearance of 3.0 m shall be maintained throughout the upending operation</p> <p>b) A minimum reserve buoyancy of 12% over the estimated weight shall be ensured in the design</p> <p>c) With any one buoyancy component fully flooded, the reserve buoyancy shall be minimum of 6%.</p> <p>3.4.16.5.5 Jacket on Bottom Stability</p> <p>Contractor shall also carry out pre-engineering survey for verification of Sea bed slope/profile and top Soil characteristic / bearing capacity upto 3m depth below mud-line. Outcome of same shall be considered for design of Mudmat.</p> <p>Adequate ballast load shall be applied in Jacket Legs, Skirt Legs & Buoyancy Tanks so that Jacket has adequate Weight (with ballast load) to sustain the installation environment (provided in the Bid) with appropriate size of Mudmat (capable to sustain the Vertical & Horizontal Load & overturning moment).</p> <p>Mudmat shall limit the penetration of jacket legs / skirt Leg below sea bed level and provide on bottom stability prior to commencement of pile foundation.</p> <p>A rigid body stability analysis shall be performed for the Jacket to ensure stability:</p> <p>a) Before pile installation (Un-piled Jacket).</p> <p>b) During all stages of pile installation (segment wise) in one diagonal of the Jacket Leg / Skirt Leg.</p> <p>c) 1st Pile or Pile segments shall get complete rundown (self-weight of Pile, self-weight of Pile + Hammer, Driving 2 blows per foot). Till completion of this activity Pile or Pile 2nd segment shall not be place on other corner of Jacket Leg or Skirt Leg.</p>			


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<p>Both still water and installation environmental conditions shall be considered. The environmental criteria during installation are given in the DC 3.4 Part – II. The Still Water Level may be defined as:- $CD + SS + LAT + 50\% AT.$ For the on-bottom weight the jacket shall be considered in all its applicable set down ballast and stabbed hanging pile configurations. The steel/ fiber glass/composite material mudmats shall be sized to provide bearing and sliding resistance. Any slope in the seabed shall be taken into account. The ultimate bearing capacity of the mudmats under combined vertical and horizontal loading shall be calculated using the methods in API RP 2A. Pile sleeve extensions or skirts, where used may be used to enhance the mudmat capacity. Critical wave heights shall be determined and checked against installation environmental conditions for jacket overturning/mudmat uplift, mudmat sliding and bearing failures. Safety factors of 2.0 for bearing failure and 1.5 for sliding failure shall be applied as per API code. Stresses on soil at corners of jacket mudmat due to gravity & Gravity with Environmental loads shall be checked during detailed engineering. The stresses at corners shall not exceed the allowable bearing capacity of soil. Diaphragm closure shall have sufficient strength to sustain hydrostatic pressure during installation of jacket.</p> <p>3.4.16.5.6 Jacket & Topsides Installation Aids 3.4.16.5.6.1 Substructure Installation Aid A. Flooding System Flooding system shall be a suitable and reliable system for the jacket legs or buoyancy Tank and/ or chamber for controlled flooding of the jacket during upending and placing on bottom. B. Grouting System Contractor shall provide a reliable grouting system for grouting of the Jacket leg/skirt sleeves with the piles. The acceptable primary grouting systems are as follows: a) Pressure grouting system. b) Single stage grouting system. In order to minimize soil contamination and to prevent grout material loss (during grouting) Grout packer / Seal shall be provided for any Grouting method adopted. Arrangement for cleaning Annulus shall be provided irrespective of Grouting Method adopted. The system proposed by the Contractor shall be of proven design. The system shall be designed as a fail-safe system to cater for all possible contingencies/eventualities such as failure of any of the components. Should the Contractor propose pressure grouting they shall furnish proof of their experience and capabilities to the satisfaction of the company. In the absence of necessary experience, the Contractor shall appoint a qualified pressure grouting sub-contractor with proven experience for execution of work. Any of the grouting systems adopted shall have provision for alternate means of grouting in case of failure of the planned system.</p>				


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<p>In case substructure leg extensions are provided in design, the grout inlet shall be taken below mudline just above the packer and the grout line shall have a protective casing up to mudline.</p> <p>The Contractor shall also provide two additional diver operated grout ports at appropriate elevations as back-up.</p> <p>Inflatable grouting packers of proven design shall only be acceptable. Properly sized air supply lines shall extend from each of the grout seals to the substructure top level. All inflatable packers shall be provided with a rupture disc installed above the inflating connections to prevent premature inflation of the packer by hydrostatic pressure in the event of inflation line getting damaged during substructure installation.</p> <p>Passive Grout Seals of proven design may be provided as an alternative to inflatable grout packers. Two seals shall be provided at each location.</p> <p>Suitable arrangement shall be provided for collection of return grout from the annulus, in case the pressure grouting system is not utilized.</p> <p>C. Buoyancy Tanks</p> <p>Buoyancy tank's supports shall be designed to withstand the effect of maximum hydrostatic pressures and slamming forces during dive as per Section 3.4.16.4.20.</p> <p>D. Skirt Pile guides</p> <p>Skirt Pile guides shall be designed for the loads imposed during the installation of the skirt piles. As a minimum following criteria shall be considered for the design of the skirt pile guide and the supporting framework.</p> <p>Top Level:</p> <ol style="list-style-type: none"> 1.5 times the weight of the lead pile section. The total weight of all pile including add-on sections supported at this level during piling operation. 0.25 times the weight of the lead section applied lateral to the plane of the supporting frame. <p>Second Level:</p> <p>The weight of the pile, which will initially pass this level.</p> <p>Subsequent Level:</p> <p>0.5 times the weight of the pile, which will initially pass these levels.</p> <p>Loading during loadout and transportation shall also be considered in the design.</p> <p>E. Pile Stabbing Guides</p> <p>Stabbing guides shall be designed to facilitate centering and alignment and to provide effective support to pile add-on sections.</p> <p>F. Chaser Pile and Pile Connections</p> <p>The CONTRACTOR shall provide adequate chaser piles for driving the skirt piles of the substructure. Use of underwater hammer is also acceptable and the use of chaser piles is not mandatory.</p> <p>Adequate pile connectors shall be used to assemble chaser pile segments and ensure a sound connection of the chaser with the skirt pile during pile driving.</p> <p>In case of difference in sizes of chaser section and skirt pile section, the actual</p>				


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<p>energy transmitted to the skirt pile shall be considered for drivability analysis. Positive type of connectors shall be used to drive skirt piles.</p> <p>G. Upending Padeyes Upending padeyes shall be designed for the maximum sling load computed during the upending operation. A lateral load of 5% of the static sling load shall be applied in addition to the lateral load computed during the upending operation. This lateral load shall be applied at the center of the pad-eye pin-hole. A load factor of 2.0 shall be considered for all the above loads. The orientation of the lower set of padeyes shall be fixed by taking into account the variation of the angle of sling with rotation of the substructure during successive stages of upending operation.</p> <p>H. Lifting Padeyes Lifting Padeyes shall be designed as per API RP 2A. The substructure legs shall have ring stiffeners at these locations to prevent ovalization of the tubular.</p> <p>3.4.16.5.6.2 Installation Aids for superstructure The minimum requirements for different installation aids for the superstructure are given in this section. CONTRACTOR shall design all installation aids to suit his method of installation for the anticipated function and loads. Applicable requirements of API RP 2A shall be followed.</p> <p>a) Lifting Eyes / Trunnions Trunnions shall be used for lifting points with a static sling load of over 600 tonnes. Lifting eyes shall be designed as per requirements of API RP 2A. The design sling load shall be computed based on an assumed tilt of 2° in the most adverse direction. The lifting eye / trunnions design shall include sufficient reserve strength to allow for future weight growth, load distribution changes and final selection of rigging</p> <p>b) Spreader Frames Spreader frames shall preferably be connected to the modules by slings. If rigid legs are provided by the Contractor they shall be adequately braced to carry sway forces. The lifting analysis of the module with spreader frames with rigid legs and sway braces shall be carried out as per clause 3.4.13.2.3 and including a side sway force of 5 percent of the vertical force in the 4 grid directions.</p> <p>c) Bumper Guides Bumper guides shall be provided on superstructure to arrest the sway of the module being installed over it and to position the module accurately. The guide system configuration and design shall be such that the guide system elements fail prior to any damage to the module or the support structure, and the connections to the support shall be stronger than the guide elements. The guide system shall be designed for a Normal load of 10 percent of the module weight in the direction of guide support and a friction force of 3 percent of the module weight in the lateral direction</p>				


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<p>acting simultaneously. Basic AISC permissible stresses shall be used in the design.</p> <p>3.4.16.5.7 Installation of Top Side by Float Over Method</p> <p>Applicable GL Noble Denton guidelines for Float-over Installation, Load outs, Marine transportation and Moorings will be followed for design and installation of Topside by Float over (FO) method onto host structure. Relevant DNV, API, BV etc. codes pertaining to marine operations will also be followed wherever required. All specific environmental data required for design and installation of topside by FO method except indicated in Design Criteria 3.4 Part II shall be collected by the Contractor .A hydraulic jacking system will be utilized for effective, rapid transfer of loads of topside to piles.</p> <p>Salient engineering guidelines for installation of Topside onto pre-installed jacket by Float over (FO) are briefly described here under.</p> <p>A. Environmental Conditions:</p> <p>The limiting design environmental conditions should be based on weather windows analysis, motions/ clearances during installation, structural strength of the barge, structures and installation components and mooring capability assessment & assurance.</p> <p>The environmental design criteria for transportation may be derived from latest GL Noble Denton Guidelines for Marine Transportation.</p> <p>The limiting environmental design criteria for mating operation may be derived from Mating Loads analysis. The limiting sea states for the mating operation will be calculated such that the maximum motions and design loads are considered for design of jacket Legs, fenders, LMUs and hydraulic jacks.</p> <p>B. Float over Barge selection</p> <p>Selected Float over Barge must satisfy the criteria indicated in latest GL Noble Denton guidelines for Float-over Installation.</p> <p>Barge stability shall be shown to be adequate throughout the installation operation and attention should be paid to:</p> <ol style="list-style-type: none"> 1. Stability checks should be carried out for the full range of probable GM values, module weight and COG predicted during installation, this must include the effects of de-ballasting the barge and jacking the module. 2. Any installation with a small metacentric height, where an offset centre of gravity (structure) may induce a heel or trim during the ballasting / weight transfer i.e. when any transverse /longitudinal moment ceases to be restrained by the host structure. 3. Cases where a change of wind velocity or wave direction may cause a significant change of heel and trim during installation. 4. During FO installation it may be necessary to maximize FO clearance by minimizing the barge draught within stability limitations. For this case only intact stability need be considered with a positive GM not less than the Flag state's minimum requirements. <p>Intact stability requirements shall be checked as per clause no. B200 of DNV –OS-H101.</p>				


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	<p>It will be also ensured that actual Still Water Bending Moment (SWBM) and Still Water Shear Force (SWSF) at any section of hull never exceed the maximum allowable SWBM and SWSF at the section during transportation and FO operations.</p> <p>Barge models will be created to compute the stability and motions of the barge during Topsiside transportation.</p> <p>Barge mooring analysis for the barge to the Jacket shall be performed to ensure that that mooring winches, wire sizes and soft crossed lines have adequate capacities to be able to hold barge in position and guide it during approach to the jacket.</p> <p>C. Barge load conditions</p> <p>The Barge loading condition for each stage of docking, mating, load transfer and undocking operation shall be determined as follows:</p> <ol style="list-style-type: none"> 1. Docking and Pre-installation case. The minimum FO clearance will be determined based on vessel draught, design of mating cones and receptacles, environmental conditions for the installation and possible maximum motion amplitudes at the mating points. 2. Mating and load transfer stages from the first contact to 100% transfer (0%, 50% & 100%). These stages shall be analyzed for the barge at intermediate draughts to allow for ballasting and fall of tide. 3. Undocking stages from 100% load transfer to separation. These stages and undocking stages shall be analyzed for the barge at deep draught, to maximize separation on a falling tide and under keel clearance. <p>D. Motion and Mating Stages:</p> <ol style="list-style-type: none"> 1. Devices to assist or control the safe entry of the installation barge in to the host structure slot shall be provided. The engineering properties (strength, stiffness, damping, hysteresis, elastomeric creep) of all components and systems for mating shall be verified by tests which cover the range of conditions (e.g. forces, displacements) anticipated for installation operation. 2. The motions of transportation barge and associated docking, mooring line and fender loads shall be analyzed in time domain for docking, load transfer and undocking positions, including non-linear effects of the host structure/deck/barge, mooring configuration, shock absorbers, fendering system, etc. 3. The motions of barge and associated docking mooring line and fender loads shall be analyzed in the time domain for several docking and undocking positions such as: <ol style="list-style-type: none"> i. Pre-docking, free floating motions with barge aligned with the first row of the structure. ii. Docking, intermediate stage with the whole barge engaged with the host structure. iii. Docked, with the barge offset from the pre-mating position, prior to finally tensioning the mating moorings. iv. Undocking with the barge in an offset position, after full transfer of the deck weight to the host structure and release of the mating moorings. 			


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<p>4. Mating stages shall be selected and analyzed in time domain to identify associated loadings to all the interfaces associated in weight transfer processes. As a minimum this shall include barge docking, load transfer and barge removal:</p> <ol style="list-style-type: none"> Pre-mating, with the barge and structure positioned in the host structure, and aligned with but prior to engaging the stabbing cones or positioning system(s) on the LMU's /host structure. First contact between the structure and host structure. Intermediate load transfer, with the structure weight partially transferred from the barge to the host structure, without any separation or lift off at support points. Last contact between the structure and support point on the barge. Post load transfer, the vessel positioned in the host structure after complete separation from the host structure. <p>5. A Monte Carlo simulation shall be performed to define maximum values with an acceptable probability of exceedance of 10% or less. The simulation period for each stationary stage shall reflect the actual operational period multiplied by a factor of two to capture a contingency period. The time step to be used shall be selected so as to identify the maximum peak motion.</p> <p>6. A Leg Mating Unit (LMU) design shall be carried out taking into account the loads, stroke and motion response expected to be applied during load transfer operations. The LMU performance characteristics shall be included in the mating analysis.</p> <p>7. An assessment shall be made to consider the speed at which the structure and barge can separate. As the barge starts to separate from the structure there will be a tendency for re-contact at the LSF / structure interface due to the barge motions. Mitigations shall be considered to avoid damage to structure and LSF / barge.</p> <p>8. A jacking system will be utilized for rapid load transfer (active Float-over). The jacking system shall be designed to ensure the stability and restraint of the structure as it is raised above its transportation position. Redundancy shall be provided in the jacking system so that there is no single point of failure in the system. Detailed HAZIDs will be required of the jacking system.</p> <p>E. Clearances</p> <p>The maximum draft of the installation barge during float-over shall not exceed the maximum loadline draft. The minimum barge freeboard at the maximum barge draft shall be 1.0m to maintain its water-plane area. Minimum freeboard used during the operation shall be confirmed with the barge owner. The limiting seastate should be such that green water cannot occur on the deck of the barge.</p> <p>During approach of the structure the minimum (static) vertical clearance between the structures stabbing cone and host structure receptacles / jacket leg / piles shall be 1.0m.</p>				


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	<p>The maximum vertical / horizontal movement of the stabbing cone should not normally exceed $\pm 0.5\text{m}$ during entry and weight transfer.</p> <p>To allow safe removal of the installation barge the minimum clearance between the keel of the installation barge and any part of the submerged host structure shall be 1.0m after accounting for vessel maximum motions at maximum draft.</p> <p>The minimum vertical clearance between the LSF and the underside of the structure following completion of load transfer shall be 0.5m after accounting for vessel maximum motions to allow safe removal of the installation barge.</p> <p>F. Barge Mooring and Positioning: Mooring and positioning of the barge into the host structure can be by:</p> <ol style="list-style-type: none"> 1. Pre-laid mooring lines/anchors 2. Tugs and pre-laid mooring lines <p>G. Barge Mooring and Stand –Off Moorings Stand-off mooring shall be provided except for vessels with suitable DP systems.</p> <p>When required, the installation barge mooring system shall be designed to resist the environmental loads, allowing the barge to maintain position prior to docking. Line integrity and anchor uplift shall also be verified for operational and extreme environment standby cases.</p> <p>A mooring analysis shall be carried out for the installation barge at the stand-off location and at the incremental stages that comply with the installation procedural steps. The mooring analyses shall satisfy the requirements of GL Noble Denton Mooring Guidelines.</p> <p>All installation barge mooring lines and tethers shall be capable of being tensioned by the use of winches or capstans.</p> <p>H. Clearances around Mooring Lines and Anchors Clearances around mooring lines and anchors should comply with GL Noble Denton Mooring Guidelines.</p> <p>All anchor lines shall be pre-installed and pre-tensioned to maximum operating loads with a safety factor and holding period to be agreed.</p> <p>I. Position Keeping During Mating with Tethers The tethers shall be designed to hold the barge in the mating position to ensure that the barge motions do not exceed the capture radius of the LMU's during the mating operation. The characteristics of the tethers shall be accurately modeled in the analysis.</p> <p>Temporary mooring tethers shall be designed for the maximum expected loads and sized based on a factor of safety of 1.67 against the certified break load.</p> <p>J. Topside Mating Analysis The static analysis of topside structure shall be carried out to ensure integrity of the integrated topside structure during mating condition. The topside geometry used shall be similar to that of transportation analysis.</p> <p>Mating Load Generation: Mating loads shall be derived from the dynamic time domain barge motion analysis. The deck will experience impact forces during the following conditions:</p>			


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<p>K.</p>	<p>1) Initial contact as the barge ballasts down and the deck columns begin to touch the jacket legs.</p> <p>2) Load transfer stage as the deck weight is 50% transferred to the jacket.</p> <p>3) Separation stage as the deck weight is fully transferred to the jacket. The LSF begin to separates from the underside of the cellar deck causing impact to the cellar deck beams.</p> <p>All loads shall be represented as concentrated loads and applied at deck stabbing point to simulate the impact loads occurring during mating conditions.</p> <p><u>Structural Analysis and Stress Check:</u></p> <p>Linear static analysis shall be carried out to determine structural member forces for each of the load cases considered.</p> <p>Member stress and joint punching shear code checking shall be undertaken in accordance with API RP 2A, 21st edition. One third increase of AISC basic allowable stresses shall be permitted.</p> <p><u>Jacket Mating Analysis</u></p> <p>The jacket structural mating analysis shall be performed to ensure that the structural integrity of substructure and foundation can withstand the impact load occurring during the mating phase of topside float over installation.</p> <p>Jacket and foundation modeling:</p> <p>The jacket and pile foundation shall be modeled as a 3D frame using SACS computer program. The model does not include the deck. Nonlinear pile-soil interaction is used as the boundary condition in the analysis.</p> <p>Mating Load Generation:</p> <p>Mating loads shall be obtained from the dynamic time domain barge motion analysis. The jacket will experience impact forces during the following conditions:</p> <ol style="list-style-type: none"> 1. Entry stage describes the loading as the barge carrying the float over deck enters the jacket between Row A and B. 2. Alignment stage describes the loads as the barge setup at position for mating process. 3. Initial contact describes the loads as the barge ballasts down and the deck columns begin to touch the jacket legs. 4. Load transfer stage describes the loads as the deck weight is 50% transferred to the jacket. 5. Load transfer stage describes the loads as the deck weight is almost completely transferred to the jacket 6. Separation stage describes the loads when all the deck weight is transferred to the jacket. 7. Exit stage describes the loads as the unloaded barge exits the jacket. <p>All loads are represented as concentrated loads and applied at top of receptors to simulate the impact loads occurring during mating conditions.</p> <p><u>Structural Analysis and Stress Check:</u></p>			


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		<p>The pile soil interaction analysis shall be carried out to ensure the structural integrity of the jacket and piles. The pile capacity should have minimum safety factor of 1.5 during mating conditions.</p> <p>Member stress and joint punching shear code checking shall be undertaken with all mating load stages in accordance with API RP 2A, 21st edition. One third increases of AISC basic allowable stresses shall be permitted.</p> <p>L. Barge Fenders: Sway fenders will be fitted to jacket legs to reduce the clearances during the mating operations. Design loads will be obtained from mating analysis report.</p> <p>M. Leg mating Units (LMU): The jacket leg will be fitted with stabbing cones mounted on Top while LMUs will be contained in the topside legs. The LMU consist of vertical and horizontal rubber pads.</p> <p>N. Hydraulic jacks: Active Float over operation shall be designed using hydraulic jacks. The topside module shall be supported on the Load out supporting frame at four contact points. Design loads shall be obtained from mating analysis report</p> <p>O. Sea Fastening: The transportation loads (cargo forces) will be transferred from the Top sides modules through the upper sea fastenings to Load out Support Frame and then through lower sea fastenings to the barge deck. The Philosophy of this arrangement shall be such that only the upper attachments need to be cut prior to installation of the Topsides on the jackets. The sea fastening structure will be analyzed for various load cases as specified for each condition and checked under the combined axial and bending stresses and shear forces as per AISC and API requirements.</p> <p>3.4.17 Welding Following welding detailing shall be incorporated in respective Drawing during drawing approval stage.</p> <p>B. Pile Drawings: In order to minimize Pile Fatigue, welding in pile shall be provided with full penetration weld from both side applicable for long seams & girth seams. Mudline zone upto 40 m below sea bed full penetration weld shall double equal V from both sides.</p> <p>C. Jacket Drawings (all type): Welds of long Seam for Jacket tubular shall be provided with full penetration Weld from both sides. All tubular to tubular Girth Joints shall be provided with full penetration Weld from both sides. Shear plate & Yoke Plate connection between Main Leg & Skirt Leg shall be provided with full penetration weld from both sides with double equal V wherever such provisions/ connections are applicable. Shear Key on Skirt sleeve & skirt Pile shall have fillet (partial penetration) weld from both side of shear key.</p>		


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				<p>Welding between Hydrostatic Collapse Ring with jacket structural member shall be full penetration weld from both sides. In the event of Hydrostatic Collapse Ring requirement arising out for pre-service analysis, then partial penetration weld from both side can be permitted with concurrence of MWS.</p> <p>Bolted connections are not acceptable for Jacket, Boat Landing, and Riser Protector & Conductor Protector.</p> <p>Conductor guide shall have full penetration weld from both sides.</p> <p>D. Welding on Hanger Clamp, Riser guide Clamp and Riser friction Clamp and Grouted Clamps for Jacket Repair:</p> <p>These clamps are experiencing cyclic loading caused due to Wave, Current & Wind and with tension loads.</p> <p>Welding between Clamp Flange Plate and Clamp shell shall be provided with full penetration weld from both sides. Welding between Clamp Flange plates to stiffener shall be provided with full penetration weld from both sides. Hanger clamp flange plate shall be provided with a hole for drainage arrangement. Welding between Stiffeners with Clamp shell shall be provided with fillet (partial penetration) weld on both side of stiffener.</p> <p>E. Welding of Deck Framing, Leg Joints, Stiffener Joints, Built-up beam:</p> <p>Welding between Flange and Web of Built-up Beam shall be provided with full penetration weld from both sides of web (single web). In case of Beam with Two webs the welding between Web and flange shall be provided with full penetration weld from one side with backing plate inside.</p> <p>In case of Boxing Plate is used as stiffener or boxed beam is planned as per design calculation, than the weld of box plate shall be provided with full penetration Weld from one side all-around.</p> <p>Beam to Beam Splice shall be full penetration weld from both sides.</p> <p>Connection between two Primary Beams shall be provided with Full penetration weld for both for Flange to flange connection and web to web connection.</p> <p>Connection for Deck leg (or for other similar tubular Columns) & Beam shall be provided with Tubular member as through member with diamond shaped flange plate connection with beams and or internal ring stiffener with full penetration weld from both sides of flange plate and or internal ring stiffener. Kindly refer Clause no. 3.4.8.1.6.1 b) of this document.</p> <p>Connection between Truss Tubular supported on beams shall be provided with Stiffener Joint. Welding between trusses tubular with beam shall be provided with full penetration weld.</p> <p>Welding between Flanges of Beam and stiffener shall be provided with full penetration weld from both sides of stiffener both at top end & bottom end with drainage arrangement. Welding between Web & Stiffener shall be fillet weld from both sides of Stiffener.</p> <p>In case of sector or half pipe is used as stiffener, the welding of sector / half pipe to Flange plate & web Plate shall be full penetration from one side.</p> <p>In case of flush floor system (Floor plate + stringer + deck beam + main girder) following are to be complied:</p> <p>a) The connection of top flanges of stringer beams/ Secondary Beams to top flanges of Primary Beams shall be full penetration from both sides.</p>


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<p>b) The connection of bottom flanges of stringer beams/ Secondary Beams to web of Primary Beams shall be fillet weld/seal weld from both sides. The bottom flanges of stringer beams/ Secondary Beams shall not be snapped.</p> <p>c) The connection of webs of stringer beams/ Secondary Beams to web of Primary Beams shall be fillet weld from both sides web.</p> <p>Items planned (as specified in Bid) or required removable shall be provided with bolted connections.</p> <p>F. Welding of Deck Plating, Building Module Floor & Wall Plating:</p> <p>Connection between Beams to Deck/Floor Plate shall be provided with seal/fillet weld continuous with beams from bottom side and all around. Connection between two plates shall be provided with full penetration weld from both sides. Connection between wall plating and supporting structural members shall be provided with seal/fillet weld continuous with beams from bottom side and all around.</p> <p>3.4.18 Deck Extension or Modification:</p> <p>This provision is applicable when platform requires extension, additions, alteration on the existing facility arising out of addition of (a) Clamp-on conductors with protector & deck extensions, (b) Riser with protector and Deck extension or modification, (c) Addition of helideck, (d) Crane pedestal and crane boom rest, (e) provisions for Modular rigs, (f) addition or replace of Equipment and Piping and related modifications & strengthening, etc.</p> <p>To carry out this scope of work, Local Analysis or Global analysis for Deck shall be required. Detail of same shall be as specified in DC 3.4 Part – II / Basic bid work.</p> <p>Primary members shall be extended to support the proposed extension. If required, knee brace and or truss members shall be added for proposed Deck Extension.</p> <p>In case strengthening of existing Truss members is required same shall be carried out by adding Tubular. In case of Strengthening of Beam, Flange extension plate and or addition of flange plate shall be added. Flange extension plate shall be provided with full penetration weld. Addition of beam flange plate shall be provided with partial penetration weld.</p> <p>Use of Doubler Plate and or external Ring Stiffener shall be provided to strengthen the Tubular to Tubular Joint. External Ring stiffener shall be provided with full penetration weld. Doubler plate shall not be used for member carrying tensile loads.</p> <p>A. Deck Global Analysis:</p> <p>SACS Model with mark-up drawings shall be generated with data obtained from the pre-engineering survey. In case SACS Model provided by Company then Pre-Engineering Survey data shall be incorporated in the SACS model.</p> <p>SACS Model shall be updated with the proposed Extension, Modification and alteration proposed along with the existing structure and various loads for the purpose of topside Global analysis. Based on the analysis, proposal for Strengthening of existing Structural Members and for proposed Deck extension shall be submitted supported with Drawings, Analysis & Design Calculation for review / approval. It shall be ensured that strengthened Member UC Ratio ≤ 1.00</p> <p>Before carrying out Deck Global analysis, data shall be obtained by carrying out pre-engineering survey:</p>				

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<div> <p>i) All Primary member (from Jacket walkway to Main deck top level) Size and thickness shall be verified with respect to available drawings/ SACS file provided by company. Mark up Drawing and new SACS file shall be prepared. Thickness gauging shall be carried out using ultrasound.</p> <p>ii) In case of Drawings / SACS file are not provided in the Bid: All Primary and secondary (from Jacket walkway to Main deck top level) member(s) size and thickness shall be obtained during pre-engineering and mark-up drawing/ SACS file shall be prepared. Thickness gauging shall be carried out using ultrasound.</p> </div> <div> <p>B. Deck Local Analysis: SACS Model with mark-up drawings shall be generated with data obtained from the pre-engineering survey. In case SACS Model provided by Company Pre-Engineering Survey data shall be incorporated in the SACS model. SACS Model shall be updated with the proposed Extension, Modification and alteration proposed for the project. SACS Model shall be incorporated with new and existing load(s) in line with the details provided in the bid document for analysis. Based on the analysis, proposal for Strengthening of existing Structural Members and for proposed Deck extension shall be submitted along with Drawings, Analysis & design calculation for review / approval. Deck local Analysis shall be limited to nearest Jacket legs for transfer of Load for WHPS and nearest deck leg truss for Process/LQ platforms. Before carrying out Deck local analysis, data shall be obtained by carrying out pre-engineering survey as detailed below:</p> <p>i. Primary and Secondary member (s) size and thickness shall be verified with respect to available drawings/ SACS file provided by the Company. Mark up Drawing shall be prepared. Thickness gauging shall be carried out using ultrasound.</p> <p>ii. In case of Drawings / SACS file are not provided in the Bid: Required portion Primary and secondary member (s) (from Jacket walkway to Main deck top level) size and thickness shall be obtained during pre-Engineering survey and mark-up drawing/ SACS file shall be prepared. Thickness gauging shall be carried out using ultrasound.</p> </div> <div> <p>3.4.19 Weight Control 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 should be established.</p> </div> <div> <p>3.4.19.1 Weight Control Report The Contractor shall maintain a detailed weight inventory of all equipment, bulk materials and consumable to be installed on the platform in the form of a Weight Control Report. This report shall be computer generated in which various building / module components constituting the platform top sides are identified under separate heads and the weight assessment of each unit shall be made for the following conditions</p> </div>				

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<p>a) Inplace mode (for dry, operating and test conditions). b) Transportation mode. c) Offshore lifting.</p> <p>This Report shall be prepared separately for all the modules, which are identified to be lifted separately offshore. For each of these items weight information shall be generally formatted as follows:</p> <ol style="list-style-type: none"> 1. Structural steel work 2. Architectural and finish material including coating and insulation. 3. Each of equipment using actual tag number for identification. 4. Piping, valves and supports (identified by name and / or tag number). 5. Electrical cabling including cable trays, supports etc. 6. Instrumentation cabling including cable trays, supports air lines, hydraulic lines, valves etc. 7. Consumable. 8. Appropriate contingencies at various stages. <p>Initial input of data shall consist of weights in which a high degree of confidence can be placed and which are backed with data taken from Vendors, latest available MTO's etc. All weight and weight changes shall be periodically monitored throughout the design. The quality of input data shall be progressively refined and ultimately result in the following:</p> <ol style="list-style-type: none"> i) Data taken from equipment and valve certificates ii) Final piping isometrics and MTO's. iii) Final structural MTO's. iv) Final MTO for electrical and instrument items. <p>A similar weight control report shall be prepared for each substructure for the transportation mode.</p> <p>3.4.19.2 Weight Monitoring and Control 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 DC 3.4 Part-II 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 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 modules. In case the as- installed weight in excess of 5% is noted redesign of affected component design shall be done at no extra time and cost to COMPANY.</p> <p>3.4.19.3 Weighing of Decks The contractor, prior to load out, shall accurately weigh platform Decks. Detailed weighing procedures shall be developed and submitted for Company's approval. The weighing activity shall include, but not be limited, to the following:</p>				


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<p>a. Weighing of module as per Company approved procedure.</p> <p>b. Prepare schedule of items both permanent and temporary on the module at the time of weighing results with the theoretical values.</p> <p>c. Reconcile weighing results with the theoretical values.</p> <p>d. Prepare a detail weight schedule of all items, which are yet to be installed, prior to lifting together with any items, which are to be removed i.e., rigging platforms etc.</p> <p>e. Prepare a final weighing report for every lift containing:</p> <ol style="list-style-type: none"> Weighing Results Theoretical Prediction Item schedule for d) above. <p>Contractor shall assume full responsibility for all remedial measures required as a result of weight escalation beyond the weights budgeted for sea transport, offshore lifting and final service operations. This Responsibility shall include but not be limited to weight reduction measures, strengthening and stiffening of the module etc.</p> <p>Actual weight with COG calculation of Deck shall be reported to respective structural Engineer (of Company) and clearance regarding further analysis shall be obtained. Contractor shall also perform a final In-place and lifting analysis of the Decks after the weighing incorporating the results of weighing. Necessary reinforcement of the structures and the modules shall be carried out before load out.</p> <p>The final In-place analysis of the substructures shall be performed after computation of deck loads based on the above and documented.</p> <p>3.4.20 Review of Structural Analysis</p> <p>Structural Analysis related to all In-Service Analysis including Foundation Design/Engineering and related Drawings shall be under approval category. CV (duly certified by Contractor's Design Consultant and by Contractor) of the Respective signatory of the Analysis Reports & Design Calculation shall be incorporated in the respective Report/ Calculation.</p> <p>Structural Analysis related to all Pre-Service Analysis, Installation Engineering and related Drawings shall be under review category. Approval / Vetting of MWS shall be obtained and submitted for Company review.</p> <p>Computer terminal with the relevant software shall be made available to the Company during the detailed engineering for the review of the computer generated Structural Analysis at Design Centre and / or at Company Office. Internet access shall be provided at Design Center with printing facility.</p> <p>Drawing, Analysis & Design calculation Submission sequence for DCI:</p> <ol style="list-style-type: none"> Foundation Design with related Drawings In-Service Analysis: Inplace Analysis along with framing Drawing applicable for Deck & Jacket. Deck Misc. Design Calculations for Primary & Secondary Structure and Joint Design calculation along with related Drawings. In-Service Analysis: Jacket Fatigue Analysis along with Fatigue Related Drawing. In-Service Analysis: Earthquake Analysis of Deck & Jacket with related Drawings. 				

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	<p>6. Jacket Misc. Design Calculations for Primary & Secondary Structure with related Drawings.</p> <p>7. Pre-Service Analysis: Load out Analysis with related Drawings (Jacket & Deck).</p> <p>8. Pre-Service Analysis: Load out Analysis with related Drawings (Jacket & Deck).</p> <p>9. Pre-Service Analysis: Transportation Analysis with Sea fastening Drawings (Jacket & Deck).</p> <p>10. Pre-Service Analysis: Lift Analysis with related Drawings (Jacket under lift method & Deck).</p> <p>11. Pre-Service Analysis: Launch Analysis with related Drawings (for Jacket under launch method).</p> <p>12. Pre-Service Analysis: Floatation & Upending Analysis with related Drawings (Jacket).</p> <p>13. Pre-Service Analysis: On bottom Stability Analysis with Mud-mat Design with related Drawings (Jacket).</p> <p>14. Pre-Service Analysis: Pile Drivability Analysis with related Drawings (Jacket piles).</p> <p>15. Pre-Service Analysis: Installation Engineering.</p> <p>16. Drawings related to Grouting Line, Flooding Line, cleaning/ flushing Line, etc.</p> <p>17. Deflection Report shall be generated for:</p> <ol style="list-style-type: none"> Each Pile deflection at mud line, Deflection at all Jacket Leg Joints at each Horizontal Framing levels, Relative deflection between two horizontal elevation Cellar Deck & Main Deck deflection at all extreme corners at 1 hour Extreme Environment. <p>Drawings under approval category shall be taken up for approval after completion of One Round In-service (all) & Pre-Service Analysis (all). In-service Analysis shall be taken up for approval after incorporation of the effects of all Pre-Service analysis.</p> <p>3.4.21 As-Built Drawing Preparation</p> <p>Contractor's Structural Design Consultant shall prepare the AS-Built Structural Drawings by incorporating all subsequent design changes approved by Company, marking actual Yield Strength of material in co-relation to Material Traceability & Mill Test Certificate with Listing of Heat Numbers, Name of Mill, Mill TC Numbers, etc. Fabricator shall provide copy of Material Inspection Report with Mill TC to the Contractor's Design Consultant for As-Built Drawing preparation. Spec 6001F Clause 3.17 shall also be referred and complied.</p> <p>3.4.22 Final Documentation</p> <p>Contractor shall submit six sets of soft copies in 1TB (minimum) SSD hard drive or better of all approved structural Drawings, Structural analysis reports including Software Analysis models in respective software format (input and output run files) of sub structure and topside including in addition to the As-Built Documentation. Pile Driving records, Weight Control Reports and final platform structural weighing Weights (of top side) shall be part of documentation. Spec 6001F Clause 3.17 shall also be referred and complied.</p>			

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<div> <h1>ANNEXURES</h1> </div>				

Annexure-1: Acronyms

Sr. No	Abbreviated Terms	Expanded Term
1	ABS	American Bureau of Shipping
2	AISC	American Institute of Steel Construction
3	AISI	American Institute of Steel and Iron
4	ALARP	As Low As Reasonably Practicable
5	API/RP	American Petroleum Institute/Recommended Practice
6	ASTM	American Society for Testing and Materials
7	AWS	American Welding Society
8	BS	British Standard
9	BOD	Basis of Design
10	BFD	Basis for Design
11	CTOD	Crack Tip Opening Displacement
12	CD	Chart Datum
13	Den	Department of Energy, UK
14	DOE	Department of Environment, UK
15	DnV	Det norske Veritas
16	DEP	Design and Engineering Practice
17	DFI	Design, Fabrication and Installation
18	EL	Elevation (relative to CD)
19	ECP	Engineering Construction and Procurement
20	FLS	Fatigue Limit State
21	HSE, UK	Health and Safety Executive
22	IMR	Inspection, Maintenance and Repair
23	ISO	International Standard Organization
24	LAT	Lowest Astronomical Tide
25	AT	Astronomical Tide
26	SS	Storm Surge
27	MSL	Mean Sea Level
28	NORSOK	Norsk Søkkel Konkuranseposisjon
29	OSHA	The Occupational Safety & Health Administration
30	PWHT	Post Weld Heat Treatment
31	PTFE	Poly Tetra Fluoro Ethylene
32	QRA	Quantitative Risk Analysis
33	ROV	Remotely Operated Vehicle
34	RSR	Reserve Strength Ratio
35	SI	International System (of Units)
36	SSIV	Sub Surface Isolation Valves
37	SOLAS	Safety of Life at Sea
38	SRA	Structural Risk Assessment
39	TEMPSC	Totally Enclosed Motor Propelled Survival Craft
40	VIV	Vortex Induced Vibration
41	WSD	Working Stress Design

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42	WHP	Well Head Platform
43	PP	Process Platform
44	LQ	Living quarter Platform



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Annexure-2: IMPORTANT CONSTANTS

Sr.no.	Name	Symbol	Values
1	Gravity	g	9.81 m/s^2
2	Density of Water	ρ_w	1000 kg/m^3
3	Density of Sea Water	ρ_{sw}	1025 kg/m^3
4	Density of Marine Growth		1400 kg/m^3
5	Density of Steel	ρ_s	7850 kg/m^3
6	Expansion of steel	V	$0.000012 / ^\circ\text{C}$
7	Modulus of elasticity of Steel	E	210000 MPa
8	Shear Modulus of Steel	G	80770 MPa
9	Specific Heat Of Steel		$520 \text{ J / kg } ^\circ\text{C}$
10	Poisson's ratio of steel	ν	0.3

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Annexure-3: List of Code & Standards, Functional Specifications

- American Institute of Steel Construction (AISC):** Manual of Steel Construction 13th Edition
- American National Standards Institute (ANSI)**
A58.1 Building code Requirements for Minimum Design Loads in Building and Other Structures.
- American Petroleum Institute (API)**


Sr. No.	Spec. No.	Description
1	API RP 2A-WSD-21 st Edition	Recommended Practice for Planning, Design and Constructing Fixed Offshore Platforms – Working Stress Design.
2	API RP 2X	Recommended Practice for Ultrasonic and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians
3	API SPEC 2B	API Specification for Fabricated Structural Steel Pipes.
4	API SPEC 2F	Specification for Mooring Chains.
5	API SPEC 5L	API Specification for Line Pipes.
6	API SPEC 2W	Specification for Steel Plates for Offshore Structures, Produced by Thermo-Mechanical Control Processing (TMCP)
7	API SPEC 2H	Specification for carbon and manganese steel plate for Offshore Platform.
8	API RP 2Z	Recommended Practice for Pre-Production Qualification for Steel Plates for Offshore Structure.
9	API SPEC 10A	Specification for Cement and materials for Well Cementing.

- National Association of Corrosion Engineers (NACE)**
RP-01-76 Recommended Practice for Corrosion Control of Steel, Fixed Offshore Platforms Associated with Petroleum Production
- United States Department of Labour – Occupational Safety and Health Administration (OSHA)**

Sr. No	Code	Description
1	29 CFR 1910	General Industry OSHA Safety and Health Standards
2	29 CFR 1917.120	Fixed Stairways in restricted area
3	29 CFR 1917.112	Guarding of Edges
4	29 CFR 1926.501 & 502	Fall Protection
5	29 CFR 3124	Stairways and Ladders

- American Society for Testing and Materials (ASTM)**

Sr. No.	Spec. No.	Description
1	ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling.

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2	ASTM A36	Standard Specification for Carbon Structural Steel
3	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc – Coated Welded and Seamless.
4	ASTM A106	Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
5	ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
6	ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
7	ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service or High Pressure Service and Other Special Purpose Applications.
8	ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
9	ASTM A312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
10	ASTM A578	Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
11	ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
12	ASTM C806	Standard Test Method for Restrained Expansion of Expansive Cement Mortar.
13	ASTM D2000	Standard classification system for Rubber Products in Automotive publications.

7. American Welding Society (AWS)

AWS D1.1 Structural Welding Code-Steel

AWS D1.3 Structural Welding Code-Steel Sheet

8. SOLAS

Regulations of the International convention for the safety of life at Sea.

9. Indian Standard Institution (ISI)

Sr. No.	Spec. No.	Description
1	IS 1893	Criteria for Earthquake Resistant Design of Structure
2	IS 883	Design of Structural Timber in Building - Code of Practice
3	IS 2062	Hot Rolled Medium and High Tensile Structural Steel - Specification
4	IS 3502	Specification for chequered plate

10. Under Writers Laboratory Inc. (UL)

Fire Resistant Directory

11. Department Of Energy, London, UK

Offshore Installation: Guidance on Design, Construction and Certification-1990 (4th Edition)

12. DNV Standard

DNV GL Rules for Classification of Steel Ships, Part V, Chapter 2, Section 4 and Part 6Chapter 1

OS-H202: Sea transport operations

RP-C205: Environmental Conditions and Environmental Loads



OS-C201: Structural Design of Offshore Units (WSD Method)
RP B401: Recommended Practice, Cathodic Protection Design
RP-C205: Recommended Practice, Environmental condition & Environmental loads

13. AISI

316/316L Stainless Steel

14. Health & Safety Executive, UK (RR: Research Report)

Sr No	Code	Description
1	RR 220	Ship Collision and capacity of brace members of fixed offshore Platform (Research Report 220)
2	RR 031	Development of design guidance for neoprene lined Clamp (Research Report 031)
3	RR 200	TEMPSC Structural Design Basis Determination

15. NORSOK Standard


Sr No	Code	Description
1	N-004	Design of steel structure
2	S-002	Working Environment
3	N-003	Action and action effects
4	M-001	Materials selection
5	M-101	Structural steel fabrication

16. List of Functional Specifications

Sr No	Specifications	Descriptions
1	6001F	Specification For Materials, Fabrication, Installations of Structure
2	2005	Protective Coating
3	2009 F	Welding And Inspections
4	4001	Cathodic Protection System for Offshore Structures
5	5102	Functional Safety Specification
6	6011	Material Specification for Building Module

17. OTC PAPERS

Sr No	Specifications	Descriptions
1	OTC Paper Number 3274	Relates to Pile driving experience of Mumbai Offshore
2	OTC Paper Number 4205	Consideration of internal friction and general guideline for reference

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Annexure–4: DESIGN LIVE LOADS


Blanket Area Live Loads for local and global design. These loads described in this section shall apply to the jacket and topsides


Table – 4.01 Local Design- Uniformly distributed area live loads for Deck Plating, Grating and Secondary Beam

Sl. No.	Item/Location	Uniformly distributed area live loads	Remarks
1	Deck Plating of Process Platform	2000 Kg/m ²	Check and reinforce for concentrated load at particular location.
2	Deck Plating of Well Platform	1500 kg/ m ²	
3	Building Module Floor	1000 kg/ m ²	
4	Roof accessible for inspection and repair	125 kg/m ²	
5	Grating Design	500 kg/m ²	

Table – 4.02 Global Design- Blanket / Uniformly distributed Area Live Load

Sl. No	Item/Location	Blanket / Uniformly distributed area live loads	Remarks
1	Plated Area of Process Platform /LQ Cellar Deck	2000 kg/m ²	All beams should be checked for the case of (actual equipment and piping dead weight + operating contents weight + 500kg/m ² on open area) and reinforced if required.
2.1	Plated Area of Well Platform (design Life 25 years)	1500 kg/m ²	
2.2	Plated Area of Well Platform (design life 15 years)	1200 kg/m ²	
3	Module areas where module skid are supported directly onto the deck main trusses/ framework	-	As per actual
4.	Potable Water Storage tank area	-	As per actual
5.	Access hatches :-		Access hatches shall be checked for appropriate concentrated load also.
5.1	Well Platform (design Life 15 years)	1200 kg/ m ²	
5.2	Well Platform (design Life 25 years)	1500 kg/ m ²	
5.3	Process/ LQ Platform	2000 kg/ m ²	
6.	Building Module floors		
	a). T.G. Room	1500kg/m ²	
	b). HVAC Area, Utility & generator room.	1000kg/m ²	-

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	c). Open areas on roofs for open storage, AHU rooms, Store rooms, Document Room, Wire line Shop, Mechanical Shop, Valve repair shop, waste heat recovery system area, laundry, hot oil tank area, Battery rooms, Transformer rooms.		675kg/m ²	In addition, Architectural Load shall be added.	
			1200 Kg/m ²	No Architectural Load.	
	d).Electrical shop, Instrument shop. Oil & Gas Laboratory.		500kg/m ² .	In addition, Architectural Load shall be added.	
			1000 Kg/m ²	No Architectural Load.	
	e). Switchgear room, T.G control room, Computer and communication room, RTU room, Telemetry room, MCC Room		500kg/m ² .	In addition, Architectural Load shall be added.	
			1000 Kg/m ²	No Architectural Load.	
	f). Living rooms, Office areas, Corridors, Toilet, Tea room.		500 kg/m ²	In addition, Architectural Load shall be added.	
			1000 Kg/m ²	No Architectural Load.	
	g). Live load on accessible roof		125kg/m ² .	This Roof is not meant for storage.	
	7.	Loading / Unloading areas	– Well Platform,	1500 kg/ m ²	-
			– Living Quarter.	1500 kg/ m ²	-
			– Process Platform	2000 kg/ m ²	-
8.	All grated areas		500 kg/ m ²	-	
9.	Open deck area live load		500 kg/ m ²		
10.	Helideck Design		Case-1: Helicopter Normal Landing	1.5 MTOM+50 Kg/m ² + Dead Load+ Wind Load (31m/sec)	
			Case-2: Helicopter Emergency Landing	2.5 MTOM+50 Kg/m ² + Dead Load+ Wind Load (31m/sec)	
			Case-3: Helicopter at Rest	1.0 MTOM+200 Kg/m ² +wind load in extreme condition	
11.	Helideck firefighting & solar panel platform		200 kg/ m ²	For global design only (Refer Table 11.2 of Annexure-11 of DC 3.4 Part-I)	
12.	Helideck uniformly distributed area live load (Case-3)		200 kg/ m ²	For global design only (Refer Table 11.2 of Annexure-11 of DC 3.4 Part-I)	
13.	Bridge Walkway Live load		150 kg/ m ²	For global design of Deck / Module / Jacket.	
14.	Bridge Walkway		250 kg/ m ²	For global Bridge Design	

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15	Bridge Landing Area	Actual Bridge Reaction Load
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Note:

1. During pile configuration stage architectural load shall be estimated from past experience / project.
2. Module reaction shall be calculated as per Annexure-6.

Table – 4.03 Open Deck Area Live Loads

Description	Area Live Loads Local Design (Kg per sq. m.)	Area Live Loads Global Design (Kg per sq. m.)
Deck Process Area, Utility& Equipment Rooms, Store Rooms, Building Module	500	500


Note: Open Deck area is defined as the area outside 0.50 M from any equipment / skid /building Module footprint area.

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Annexure – 5: Gust period for Design Wind Forces/ Load

Wind areas shall also be included for equipment items on the deck and module/storage and wave forces shall be calculated as follows:

Sr No	Type of Analysis	Gust Period
a)	Jacket In-place Analysis	1 Hr. Average
b)	Deck In-place Analysis	1 Min. Average
c)	Building/Module Frame Analysis	5 Sec. gust
d)	Cantilever Structures, towers, vents, flare booms, bridges of length less than 50 M	3 Sec. gust
e)	Exterior Wall panels of buildings, barrier walls, including their stiffeners	3 Sec. gust
f)	Bridge Greater than 50 M length	15 Sec. gust

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Annexure–6: Reactions from Building modules for global in-service analysis

(These loads are for actual Equipment (Architectural) load with open area live Load of 500 kg/m²)

Sl. No.	Item	Load to be considered for calculating reactions
1	For deck in-place analysis	Module & Equipment dead weight + Architectural Load + operating content + 375 (75% of 500) kg /sqm on open area of each floor and accessible roof + Wind Load.
2	For jacket in-place conditions and for jacket and deck earthquake analysis.	Module & equipment dead weight + Architectural Load + operating content weight + 300 (60% of 500) kg/sqm on open area of each floor and accessible roof + Wind Load.
3	Jacket uplift condition	Module & equipment dead weight & Architectural Load + Wind Load.

Notes:

- (a) The term “Equipment and piping dead weight (Refer Load Combination Table)” includes dead loads of equipment, piping including pipe supports, electrical cables , cables and cable trays, instruments and instrument trays .
- (b) Helicopter data shall be as given in Table 11.3 of Annexure-11.
- (c) For Global Design appropriate percentages of the live load figures given in Table 4.02 of annexure-4 and this-annexure shall be used as specified in the respective load combination tables.
- (d) No live load is to be considered on walkways, landing, stairways, and loading/ unloading areas of the modules for calculating the reactions from building.
- (e) For substructure / pile design no live load to be considered on helideck, solar panel, platforms and firefighting platforms for calculating reactions from building modules.
- (f) Open deck area is defined as area outside 0.5m from any equipment /skid/building module foot print area.
- (g) No live load shall be considered on grated area of jacket walkway, and boat landing for global analysis (Jacket).

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Annexure – 7: Load Combinations

Table 7.1: Load Combination for Sub- structure Analysis

The in-place integral - structural analysis of the idealized deck - substructure - pile - soil system shall be performed as a minimum for following load combinations.

Load Combination No.1(a)	Extreme storm condition with operating loads & minimum deck area live loads
Load Combination No.1(b)	Extreme storm condition with maximum deck area live loads or blanket loads
Load Combination No.2(a)	Operating storm condition with operating loads & minimum deck area live loads
Load Combination No.2(b)	Operating storm condition with maximum deck area live loads or blanket loads
Load Combination No.3	Extreme storm condition with empty equipment to check the capacity of the piling under the maximum uplift force.
Load Combination No.4	Earthquake with operating load
Load combination No. 5*	<i>Modular rig with extreme storm condition</i>
Load combination No. 6*	<i>Modular rig with operating storm condition</i>


****(If modular rig operation over the proposed platform is specified in scope)***

Environmental Parameter furnished in Annexure-13 of DC 3.4 Part-I is not matching (within tolerance of $\pm 5^\circ$) then it shall be derived by linear interpolation from nearest two directions.

In summary the design load combinations for substructure analysis shall be as given in the following Table-7.1.1:

TABLE 7.1.1: Load Combination for Sub- structure Analysis

LOAD CASE	LOAD COMBINATION AS SUM OF LOAD CASE PERCENTAGE							
	1a	1b	2a	2b	3	4	5*	*6
Extreme Storm Wind, Wave & current	100	100	NA	NA	100	NA	100	NA
Operating, Storm Wind, Wave & current	NA	NA	100	100	NA	NA	NA	100
Structural Dead Loads & Buoyancy	100	100	100	100	100	100	100	100
Equipment & Piping Dead Weight	100	0	100	0	100	100	100	100
Equipment & Piping Operating Contents Weight	100	0	100	0	0	100	100	100
Open Deck area live load	50	0	100	0	0	50	50	50
Uniformly distributed deck area live load for plating and grated area. (without any deduction in area of equipment footprint)	0	60	0	60	0	0	0	0
Loading/unloading area of deck	60	60	60	60	0	60	0	0

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Crane dead load	100	100	100	100	100	100	100	100
Crane operating loads	0	0	0	0	0	0	0	0
Elastic bending forces due to curved conductors	100	100	100	100	100	100	100	100
Riser dead loads	100	100	100	100	100	100	100	100
Reaction from Bridge including walkway live load	100	100	100	100	100	100	100	100
Reactions from modules	100	100	100	100	100	100	100	100
Earthquake load	NA	NA	NA	NA	NA	100	0	0
Modular rig (Hook load is to be converted as Dead Load)*	0	0	0	0	0	0	100	0
Modular rig (with hook load)*	0	0	0	0	0	0	0	100

****(If modular rig operation over the proposed platform is specified in scope)***


NOTES:

- 1 Process Platform Substructure shall be analyzed for load condition No. 1 (1a or 1b) and 2 (2a or 2b), whichever is governed by higher magnitude of deck loads.
- 2 Well platforms sub structure shall be analyzed for load combination Nos. 1, 2, 3, 4, 5 and 6 with disturbed soil conditions due to jack up rig deployment.
- 3 Undisturbed soil Conditions shall be considered for load combination No. 4.
- 4 For uplift condition of substructure and piles only weights of permanently placed equipment and piping shall be considered (Load combination 3).
- 5 If a monsoon is envisaged to intervene between the installation of substructure and the installation of the deck, the substructure shall also be analyzed separately for extreme storm condition. For well platform, only dead load of temporary deck shall be considered. An appropriate number of risers and no increase in member diameter due to marine growth shall be considered for such an analysis. Coefficients of drag and mass shall be taken corresponding to smooth surfaces.
- 6 No Blanket area load shall be considered below module foot-print area.

Table 7.2: Load Combination for Deck Analysis

The entire deck structure including all primary and secondary trusses and frames with a portion of substructure shall be analyzed as 3-dimensional space frame. Deck structural analysis shall be carried out as a minimum for the following loading combinations:

Load Combination No.1	Extreme storm condition with operating loads and minimum deck area live loads
Load Combination No.2	Extreme storm condition with maximum deck area live loads or blanket loads

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Load Combination No.3	Operating storm condition with operating loads and minimum deck area live loads
Load Combination No.4	Operating storm condition with maximum deck area live loads or blanket loads
Load Combination No. 5	Normal operating loads plus crane operating Load.
Load Combination No. 6	Earthquake with operating loads
Load combination No. 7*	Modular rig loading with extreme storm
Load combination No. 8*	Modular rig loading with operating storm
Analysis for load combinations Nos.1 to 4, 7 and 8 shall be carried out for minimum 8 storm approach directions for each load combination.	

** (If modular rig operation over the proposed platform is specified in scope)*

In summary the load conditions shall be as given in the following **Table- 7.2.1**

TABLE – 7.2.1: Load Combinations for Deck Analysis:

LOAD CASE	LOAD COMBINATION AS SUM OF LOAD CASE PERCENTAGE							
	1	2	3	4	5	6	*7	*8
Extreme Storm Wind, Wave & Current	100	100	NA	NA	0	NA	100	NA
Operating Storm Wind, Wave & Current	NA	NA	100	100	0	NA	NA	100
Deck Structural Dead Loads	100	100	100	100	100	100	100	100
Equipment & Piping Dead Weight	100	0	100	0	100	100	100	100
Equipment & Piping Operating Contents Weight	100	0	100	0	100	100	100	100
Open Deck area live load	100	0	100	0	100	50	100	100
Uniformly distributed deck area live load for plating area. (without any deduction in area of equipment footprint)	0	75	0	75	0	0	0	0
Uniformly distributed deck area live load for grated area.	0	75	0	75	0	0	0	0
Loading/unloading area of deck	100	100	100	100	100	60	0	0
Crane dead loads	100	100	100	100	100	100	100	100
Crane operating loads	0	0	0	0	100	0	0	0
Reaction from Bridge including walkway live load	100	100	100	100	100	100	100	100
Reaction from Modules	100	100	100	100	100	100	100	100
Earthquake	NA	NA	NA	NA	NA	100	0	0

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Modular rig (Hook load is to be converted as Dead Load on capping Beam)*	0	0	0	0	0	100	100	0
Modular rig (with hook load)*	0	0	0	0	0	100	0	100

**(If modular rig operation over the proposed platform is specified in scope)*

NOTES:

1. For Earthquake analysis loading on deck shall be considered same as for substructure analysis.
2. Deck crane operating loads shall be considered for 8 orientations of boom in combination with deck equipment and piping operating loads. Crane operating loads shall include impact factors.
3. Deck analysis shall be carried out along with Building Module cum Helideck as integrated module for Well Platform.
4. No Blanket area load shall be considered below module foot-print area.

Table – 7.3 Load Combinations for Module/ Building Frame Analysis

A 3-dimensional analysis of building module shall be performed consisting of all primary trusses and frames of the module. Helideck when an integral part of the building shall be included in the framework. Structural interaction between building module and deck need not be considered. Modules analysis shall be carried out as a minimum for the following loading combinations:

Load combination No.1	Extreme storm condition with operating loads & minimum deck area live loads
Load combination No. 2	Extreme storm condition with maximum deck area live loads or blanket loads
Load combination No.3	Operating storm condition with operating loads & minimum deck area live loads
Load combination No.4	Operating storm condition with maximum deck area live loads or blanket loads
Load combination No.5	Normal operating loads plus crane operating loads.
Load condition No. 6	Earthquake condition with operating loads

The load conditions are summarized in the following **Table- 7.3.1:**


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TABLE – 7.3.1 Load Combinations for Building Frame Design:

LOAD CASE	LOAD COMBINATION AS SUM OF LOAD CASE PERCENTAGE					
	1	2	3	4	5	6
Extreme Storm Wind	100	100	NA	NA	NA	NA
Operating Storm Wind	NA	NA	100	100	NA	NA
Dead Load of Module	100	100	100	100	100	100
Equipment & Piping Dead Weight	100	0	100	0	100	100
Equipment & Piping Operating Contents Weight	100	0	100	0	100	100
Live load on each floor and accessible roof	100	0	100	0	100	100
Uniformly distributed area live load on building floor	0	75	0	75	0	0
Crane dead loads	100	100	100	100	100	100
Crane operating loads	0	0	0	0	100	0
Grated areas	0	0	20	20	20	20
Loading/Unloading areas	100	100	100	100	100	100
Helideck Uniformly distributed area Live Load excluding solar panel and firefighting platform	100	100	100	100	100	100
Reaction from Bridge including walkway live loads	0	0	100	100	100	100
Earthquake load	NA	NA	NA	NA	NA	100
Modular Rig Camp Operating Load*	100	100	100	100	100	100

**(If modular rig operation Load on the proposed Well Platform if specified in scope)*

NOTE:

1. Crane loads are applicable if they are supported by the respective module.

Table- 7.4 Load Combinations for Pre-Service Analysis

Basic Loads	Load Combinations			
	Fabrication	Load out	Transportation	Installation
Structure Dead Loads	100	100	100	100
Structure Dead Loads + Buoyancy	-	-	-	100
Dry Equipment, Piping, Cabling etc.	100	100	100	100
Crane Dead Loads	100	100	100	100
Wind Loads:				
Fabrication & transportation	100			
Load out		100		
Transportation at sea			100	
Installation				100
Wave + Current Loads:				
Installation				100
Fabrication Loads	100			
Load out Loads		100		
Sea Transportation Loads			100	
Installation Loads				100



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Annexure–8: Increase in Permissible Stresses

Sl No	Type of Analysis	Load Condition	Permissible increase	Percentage
1	Global In-Service	Extreme Environment	33%	
2		Operating Environment	Nil	
3		Earthquake – Jacket & Deck	70%	
4		Earthquake – Deck supported structures (Modules)	33%	
5	Global Pre-service	Load out	Nil	
6		Transportation	33%	
7		Launch	Nil	
8		On bottom Stability – Installation sea state included in calculation of member forces and stresses	33%	
9		Lift	Nil	
10	Local In –service	Extreme Environment	33%	
11		Operating Environment	Nil	
12		Boat Impact (for case other than the design of supports of riser protector welded to the jacket)	33%	
13		Wave Slam	33%	
14		Vessel Hydro test	Nil	
15	Local Pre-service	Launch	Nil	
16		Wave Slam	33%	
17		Mud-mat & Supports – Installation sea state included in calculation of member forces and stresses	33%	


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Annexure–9: Minimum Load Contingencies

SL NO	Items	For Process / LQ Platform	For Wellhead Platform
a.	Substructure Dead Weight over and above the weight allowance for accounting mill tolerance (refer 3.4.9 of DC 3.4 Part-I)	5	5
b.	Superstructure Dead Weight over and above the weight allowance for accounting mill tolerance (refer 3.4.9 of DC 3.4 Part-I)	10	5
c.	Building Architectural Items	15	5
d.	Equipment and Piping Dead Weight	15	5
e.	Equipment and Piping Operating Weight	15	5

NOTE:

- 1 Above stated contingencies shall be considered in all in-service Analysis.
- 2 Reductions to the amount of contingency to reflect the relative confidence level in the weight data can be considered for pre-Service Analysis at the advance stage of Engineering.
- 3 Above stated contingencies shall not be applied for pile force analysis under uplift condition.
- 4 No contingencies for items listed under SL NO c, d and e shall be applicable for in-service analysis after obtaining final WCR in case of well head platform.

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Annexure -10: Parameters for Pile Drivability Analysis

I. Dynamic Soil Parameter Input

Soil Type	Damping Coefficient (Sec/M)		Quake (mm)	
	Side	Point	Side	Point
Clay	0.656	0.033	2.54	2.54
Sand	0.164	0.492	2.54	2.54


Notes: For layered soil, weighted average of side damping value shall be used.

II. Soil Resistance to Driving (SRD) Input

Soil Type	Continuous Driving case (Lower Bound)				Set up Driving Case (Upper Bound)			
	Skin Friction (outer wall) w.r.t. Static Capacity	Skin Friction (inner wall) w.r.t. Static Capacity	End Bearing w.r.t. Static Capacity	Set up factor	Skin Friction (outer wall) w.r.t. Static Capacity	Skin Friction (inner wall) w.r.t. Static Capacity	End Bearing w.r.t. Static Capacity	Set up factor
CLAY	50%	25%	100%	1.00	85%	42.5%	100%	1.00
SAND	100%	50%	100%	1.00	100%	50%	100%	1.00

NOTE:

- Pile Drivability Analysis (upto target penetration) shall be carried out with above stated parameters for Pile Plugged & Un- Plugged condition with Continuous Driving (Lower Bound) and soil Set-up condition driving (Upper Bound).
- In case, Pile Drivability Analysis is not carried out for un-plugged case for Full Set-up Condition then Pile Driving after removal of Soil Plug shall become the part of Drivability Analysis and post Pile driving Soil plug inside the Pile shall be build-up. Cost for removal of soil plug, driving Pile and building up the internal soil Plug shall be borne by Contractor.
- Unplug Driving Case, the internal skin friction is to be accounted by increasing the pile perimeter value (as per software manual).
- Blow count obtained from Pile Drivability analysis needs to be less than the blow count limit provided by Software or Hammer Manufacturer for sizing Hammer. Pile refusal Criteria provided by API RP 2A is for field observation only and does not come in to picture for Hammer selection.
- Hammer Designated for Conductor Driving shall be IHC S-90 /IHC S150 or equivalent. Backup Hammer for Conductor Driving shall be IHC S-150 or equivalent. Maximum operated energy for both Hammer designated and backup hammer for conductor driving shall not exceed 145kJ. Conductor driving refusal criteria with a properly operating hammer is defined as the point where conductor driving resistance exceeds 270 blows per feet (0.3 m) at 145KJ. Conductors are to be driven to 70 meter penetration below seabed or the point of refusal whichever is earlier.

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Annexure–11: Helideck Design

Table – 11.1: Helideck Frame Analyses & Design Live Load

The entire helideck primary trusses and frames shall be analyzed as 3-dimensional space frame. Helideck structural analysis shall be performed for the following load combinations:

Load Combination No.1 (Extreme storm condition).

Without helicopter static loads on helideck. Appropriate live load on entire helideck and other dead and live loads under extreme storm conditions. [Case-1]

Load Combination No.2 (Static helicopter under operating storm condition).

Static helicopter load at the center of helideck plus appropriate live load on entire helideck, Fire Fighting Platform, Solar Deck, walkway, stairs and landings in combination with operating storm conditions. [Case-1]

Load Combination No.3 (Helicopter landing condition).

Helicopter landing loads at different positions with wheels at various position plus appropriate dead and live loads (on solar Deck, Firefighting Platform and other grated areas except on helideck). Helicopter Wheel Position at Center of Helideck, at various positions at the periphery (1.5 m inside) and at mid-way positions between Centre & Periphery. [Case-1]

Load Combination No.4 (Helicopter Crush Landing condition).

Helicopter Crush Landing positions with wheels at various position plus appropriate dead and live loads (on solar Deck, Firefighting Platform, and other grated areas except on helideck). Helicopter Wheel Position at Center of Helideck, at various positions at the periphery (1.5 m inside) and at mid-way positions between Centre & Periphery. [Case-2]


Load Combination No.5 (Modular Rig Living Quarter Load, if applicable).

Static helicopter load at the center of helideck over the (Modular Rig Camp) plus appropriate live load on entire helideck, Modular Rig Camp operating load, Fire Fighting Platform, Solar Deck, walkway, stairs and landings in combination with operating storm conditions. [Case-1]

In summary the loads to be considered for various combinations are given in the following Table 15.1.

TABLE – 11.1.1: Load Combination for Helideck Global Analysis

Load Case	Load Combination as sum of load case percentage				
	1	2	3	4	5
Extreme storm wind	100	NA	NA	NA	NA
Operating storm wind	NA	100	NA	NA	100

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Structural dead loads and dead loads of solar panel platform, firefighting platform and equipment	100	100	100	100	100
Uniformly distributed area live loads on helideck	50	100	0	0	100
Static helicopter load	NA	100	NA	NA	100
Landing condition load with impact at various position on helideck	NA	NA	100	NA	NA
Crush Landing condition load at various position on helideck	NA	NA	NA	100	NA
Live loads on Grated areas	0	50	50	50	50
Live load on Solar panel platform and firefighting platform	0	50	50	50	50
Modular Rig Camp Load for Well Platform (if applicable).	NA	NA	NA	NA	100

Notes: 1. Four orthogonal & four Diagonal wind directions shall be considered for extreme and operating storm conditions.

2. Wind loads on Solar panels shall be included in the analysis (wherever applicable).

TABLE - 11.2 Helideck Design Load:-


1.	Helideck beam (local design only)	Case-1 Static helicopter load plus uniform live load of 50 kg/ m ² over the Helideck. Case-2 Helicopter landing & Crush Landing impact load at various position.	For Case -2 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.
2	Helideck firefighting & solar panel platform	200 kg/ m ²	For global design only (Refer Table 10 III)
3.	Helideck uniformly distributed area live load.	200 kg/ m ²	For global design only (Refer Table 10 III)

1. For substructure/pile design no live load to be considered on Helideck, solar panel platforms and firefighting platforms for calculating reactions from building modules.

2. For deck truss design consider a live load of 100 kg/m² on helideck only for calculating reactions from building modules.

Table - 11.3: Static Helicopter Data Relevant to Helideck Design

DETAIL (1)	Bell 212 (2)	Bell 412 (3)	Westland WG 30 (4)	Sikorsky		Dauphin SA 365 N2 (7)	MIL Mi8 (8)	Sikorsky S-61-N (9)
				S76 (5)	S76-B (6)			
Gross WT (MT)	5.08	5.26	5.80	4.67	5.03	4.30	12.00	9.30
Main Rotor Dia (mm)	14.7	14.02	13.31	13.41	13.41	11.93	21.3	18.9


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Overall Length (M)	17.5	17.10	15.91	16.0	16.0	13.68	25.24	22.25
Landing Gear type	SKID	SKID	WHEEL	WHEEL	WHEEL	WHEEL	WHEEL	WHEEL
No of Gears								
-Nose	2	2	1	1	1	1	1	2
-Rear	2	2	2	2	2	2	2	1
No of Wheels								
Gear	-	-	1	1	1	1	2	2
-Nose	-	-	1	1	1	1	1	1
-Rear								
Spacing of Wheels (mm)								
-Nose	-	-	-	-	-	-	275	330
Distance between nose & rear gear (M)	2.3	2.322	5.45	5.0	5.0	3.61	4.26	7.2
Transverse Spacing (M)	2.7	2.178	3.1	2.44	2.44	1.9	4.5	4.3
% of gross WT. Per Gear								
-Nose	40	10	20	25	25	NA	41.67	43
-Rear	34	40	40	37.5	37.5	NA	28.17	15
Tyre Pressure (Psi)								
-Nose	-	-	55	140	120	79.75	64	75
-Rear	-	-	55	160	135	123.25	78	70

NOTE:

1. Helideck for Living Quarters & Process Platform shall be designed for all listed Helicopters. Overall length and Gross weight shall be separate maximum of values given column (2) through (9).
2. Well platforms shall be designed for all Helicopters except MI-8 and SIKORSKY S6IN. Overall length and Gross weight shall be separate maximum of values given in column (2) through (7).


Annexure–12: Deflection Limit

Sr. No.	Structural Element	Limiting Deflection
1	Beams	
1.a	Cantilevers	L/180
1.b	Beams supporting major items of equipment	L/360
1.c	Beams supporting sensitive equipment subject to dynamic loads	L/500
1.d	Cantilevers Beams supporting sensitive equipment subject to dynamic loads	L/250

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1.e	Secondary beams	L/360
2	Floor plate	L/250
3	Crane gantry beams	
3.a	Vertical Deflection due to static wheel load	L/750
3.b	Horizontal deflection	L/500
4	Bridge	
4.a	Vertical Deflection	L/400
4.b	Horizontal deflection due to wind load	L/500
5	Grating	L/200

Where “L” is the effective span of the member

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Annexure – 13: Environmental Parameters

Tide, Wave, Current & Wind Parameters

A. Mumbai High Field (North & South)

Extreme Storm Parameters (100 years)


*Direction (From)	Tide (m)		Max Wave		Current (m/s) (Y is the depth of water and currents are measured from bottom)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	3.261	0.091	13.86	12.20	0.457	0.914	1.097	1.310	1.493	1.676	149.67
North East	3.261	0.152	15.24	12.80	0.426	0.853	1.036	1.219	1.402	1.585	149.67
East	3.261	0.122	14.63	12.60	0.365	0.731	0.914	1.066	1.249	1.402	149.67
South East	3.261	0.183	15.54	12.90	0.396	0.762	0.944	1.097	1.280	1.432	149.67
South	3.261	1.158	19.20	14.70	0.396	0.792	0.975	1.127	1.310	1.463	149.67
South West	3.261	1.127	18.44	14.30	0.396	0.762	0.945	1.097	1.280	1.432	149.67
West	3.261	1.067	17.68	14.00	0.365	0.731	0.914	1.066	1.249	1.402	149.67
North West	3.261	1.097	17.98	14.10	0.426	0.853	1.036	1.219	1.402	1.585	149.67

Operating Storm Parameters (1 year)

*Direction (From)	Tide (M)		Max. Wave		Current (m/sec) (Y is the depth of water and currents are measured from bottom)					Wind (km/h)
	AT	Storm	Height (M)	Period (Sec)	Bottom	Y-1/4	Y-1/2	Y-3/4	Surface	1-Hour average
All Direction	3.26	0.61	11.583	11.00	0.476	0.878	1.049	1.22	1.387	99.22

Environmental Parameters for Installation Condition

Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained

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4.39	4.00	7.8	0.426	0.701	48.27	

Environmental Parameters for Fatigue Analysis


Deterministic Fatigue

Recommended Wave Period for Specified Wave Height Categories:

Wave Height (m)		Wave Period in Sec (Direction from)							
		N-Dir	NE-Dir	E- Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	5	5	5	5	6.1	6.3	6.3	5.7
0.61	1.21	5.4	5.4	5.4	5.4	6.5	6.7	6.7	6.1
1.22	1.82	5.7	5.7	5.7	5.7	6.8	7	7	6.4
1.83	2.43	6	6	6	6	7.1	7.4	7.3	6.7
2.44	3.04	6.3	6.3	6.3	6.3	7.4	7.8	7.8	7
3.05	3.65	6.6	6.6	6.6	6.6	7.7	8.2	8.1	7.3
3.66	4.26	6.9	6.9	6.9	6.9	8	8.6	8.6	7.6
4.27	4.87	7.2	7.2	7.2	7.2	8.3	9	9	8
4.88	5.48	7.5	7.5	7.6	7.5	8.6	9.4	9.3	8.3
5.49	6.09	7.8	7.7	7.9	7.7	8.9	9.6	9.6	8.5
6.10	7.61		8.1		8.1	9.1	9.9	9.8	8.6
7.62	9.13					9.3	10.1	10	
9.14	10.66						10.4	10.3	
10.67	12.16						10.6		

Number of Waves in 1 Year in Selected Wave Heights Categories:

Wave Height (m)		N-Dir	NE-Dir	E-Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	370901	303197	82423	47098	64761	565182	903701	606393
0.61	1.21	164217	134241	36492	20853	28672	250236	400119	268482
1.22	1.82	70036	57251	15564	8894	12229	106720	170639	114502
1.83	2.43	29868	24417	6637	3793	5215	45514	72776	48833
2.44	3.04	12739	10413	2831	1617	2224	19411	31037	20826
3.05	3.65	5432	4441	1207	690	949	8278	13237	8882
3.66	4.26	2317	1894	515	294	404	3531	5645	3788
4.27	4.87	1188	784	213	122	168	1461	2337	1569
4.88	5.48	472	441	125	71	67	591	945	633
5.49	6.09	63	174	45	22	43	248	396	435
6.10	7.61	0	9	0	4	20	278	444	180
7.62	9.13	0	0	0	0	3	38	70	0

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9.14	10.66	0	0	0	0	0	7	6	0
10.67	12.16	0	0	0	0	0	2	0	0

Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for All Directions

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	2	0	0	0	0	0	0	2
2.5-3.4	14	8	2	0	0	0	0	24
3.5-4.4	55	30	9	3	1	0	0	98
4.5-5.4	70	74	35	13	3	2	0	197
5.5-6.4	69	73	41	23	13	8	0	227
6.5-7.4	34	65	41	24	15	17	1	197
7.5-8.4	10	19	19	17	14	17	2	98
8.5-9.4	6	9	9	8	7	10	1	50
9.5-10.4	6	7	5	4	4	3	0	29
10.5-11.4	5	6	4	3	3	2	0	23
11.5-12.4	3	5	3	3	2	1	0	17
12.5-13.4	3	4	2	2	2	1	0	14
13.5-14.4	2	3	2	2	1	1	0	11
14.5-15.4	2	2	1	1	1	1	0	8
15.5 Plus	1	1	1	1	1	0	0	5
Total	282	306	174	104	67	63	4	1000

Direction	Percentage Occurrence
N	12.6
NE	10.3
E	2.8
SE	1.6
S	2.2
SW	19.2
W	30.7
NW	20.6
Total	100

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B. Bassein & Satellite and Neelam & Heera Field

Extreme Storm Parameters (100 years)

*Direction (From)	Tide (M)		(Max Wave)		Current (m/s)						Wind (Km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	4.572	0.213	15.24	13.10	0.640	1.036	1.250	1.494	1.707	1.920	149.67
North East	4.572	0.000	10.98	11.20	0.609	1.006	1.189	1.402	1.585	1.767	149.67
East	4.572	0.000	9.45	10.70	0.548	0.945	1.097	1.250	1.372	1.524	149.67
South East	4.572	0.000	11.59	11.40	0.579	0.975	1.128	1.280	1.402	1.554	149.67
South	4.572	1.402	17.68	14.40	0.609	1.006	1.189	1.341	1.524	1.676	149.67
South West	4.572	1.371	17.07	14.00	0.548	0.945	1.097	1.250	1.372	1.524	149.67
West	4.572	1.310	16.46	13.60	0.518	0.914	1.036	1.189	1.311	1.432	149.67
North West	4.572	1.341	16.76	13.80	0.609	1.006	1.219	1.433	1.615	1.828	149.67

Operating Storm Parameters (1 year)


*Direction (From)	Tide (M)		Max. Wave		Current (m/sec) (Y is the depth of water and currents are measured from bottom)					Wind (Km/h)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/4	Y-1/2	Y-3/4	Surface	1-Hour average
All Direction	4.39	0.61	11.58	11.0	0.476	0.878	1.049	1.22	1.387	99.22

Environmental Parameters for Installation Condition

Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.36	4.00	8.3	0.426	0.701	48.27

Environmental Parameters for Fatigue Analysis

Deterministic Fatigue


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Recommended Wave Period for Specified Wave Height Categories:

Wave Height (m)		Wave Period in Sec (Direction from)							
		N-Dir	NE-Dir	E-Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	5	5	5	5	6.1	6.3	6.3	5.7
0.61	1.21	5.4	5.4	5.4	5.4	6.5	6.7	6.7	6.1
1.22	1.82	5.7	5.7	5.6	5.7	6.8	7.1	7.1	6.4
1.83	2.43	6	6	5.9	6	7.1	7.4	7.4	6.7
2.44	3.04	6.3	6.3	6.2	6.3	7.4	7.8	7.8	7
3.05	3.65	6.6	6.6	6.5	6.6	7.7	8.2	8.1	7.2
3.66	4.26	6.9	6.9	6.8	6.9	8	8.6	8.5	7.4
4.27	4.87	7.2	7.1		7.2	8.2	8.9	8.8	7.6
4.88	5.48	7.5				8.4	9.1	9	7.8
5.49	6.09	7.8				8.6	9.3	9.3	8.1
6.10	7.61	8.1				8.8	9.6	9.6	8.4
7.62	9.13					9	9.8	9.8	
9.14	10.64						10.1	10.1	

Number of Waves in 1 Year in selected wave height categories:

Wave Height (m)		N-Dir	NE-Dir	E-Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	390830	319488	86851	49629	68240	595550	952261	638976
0.61	1.21	160891	131522	35754	20431	28092	245166	392011	263043
1.22	1.82	63723	52091	14160	8091	11126	97101	155261	104182
1.83	2.43	25238	20631	5609	3205	4407	38458	61493	41262
2.44	3.04	9996	8171	2221	1270	1745	15232	24355	16343
3.05	3.65	3920	3205	1175	497	685	5975	9553	6410
3.66	4.26	1532	1543	282	250	267	2335	3732	2504
4.27	4.87	626	611	0	85	110	951	1524	1022
4.88	5.48	367	0	0	0	48	419	669	449
5.49	6.09	104	0	0	0	18	156	251	244
6.10	7.61	6	0	0	0	16	131	216	88

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7.62	9.13	0	0	0	0	1	19	25	0
9.14	10.64	0	0	0	0	0	3	2	0

Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for All Directions

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	3	0	0	0	0	0	0	3
2.5-3.4	17	7	1	0	0	0	0	25
3.5-4.4	65	29	8	3	1	0	0	106
4.5-5.4	83	71	33	12	3	2	0	204
5.5-6.4	82	72	39	23	12	6	0	234
6.5-7.4	40	63	38	24	13	13	0	191
7.5-8.4	12	18	18	16	12	12	1	89
8.5-9.4	8	9	8	7	6	7	0	45
9.5-10.4	7	7	5	4	3	2	0	28
10.5-11.4	5	5	4	3	2	1	0	20
11.5-12.4	4	5	3	2	2	1	0	17
12.5-13.4	3	4	2	2	2	1	0	14
13.5-14.4	3	3	2	1	1	1	0	11
14.5-15.4	2	2	1	1	1	1	0	8
15.5 Plus	1	1	1	1	1	0	0	5
Total	335	296	163	99	59	47	1	1000

Direction	Percentage Occurrence
N	12.6
NE	10.3
E	2.8
SE	1.6
S	2.2
SW	19.2
W	30.7
NW	20.6
Total	100

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C. Tapti Field

Extreme Storm Parameters (100 years)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (Km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	4.36	0.00	10.97	11.20	0.701	1.067	1.219	1.402	1.554	1.707	149.67
North East	4.36	0.00	10.67	11.10	0.792	1.158	1.341	1.524	1.707	1.890	149.67
East	4.36	0.00	10.36	11.00	0.671	1.006	1.158	1.341	1.494	1.646	149.67
South East	4.36	0.00	11.89	11.50	0.549	0.823	0.945	1.097	1.219	1.341	149.67
South	4.36	1.68	17.22	14.40	0.701	1.067	1.219	1.402	1.554	1.707	149.67
South West	4.36	1.65	16.61	14.00	0.762	1.128	1.311	1.463	1.646	1.798	149.67
West	4.36	1.58	16.00	13.60	0.518	0.792	0.914	1.036	1.158	1.280	149.67
North West	4.36	0.00	10.67	11.10	0.579	0.884	1.036	1.158	1.311	1.433	149.67

Operating Storm Parameters (1 year)


*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
All Directions	4.267	0.884	9.754	10.20	0.579	0.884	1.006	1.158	1.280	1.402	80.47

Environmental Parameters for Installation Condition

Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.36	4.00	7.8	0.70	1.46	48.27

Environmental Parameters for Fatigue Analysis

Deterministic Fatigue

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Recommended Wave Period for Specified Wave Height Categories

Wave Height (m)	Wave Period in Sec (Direction from)							
	N	NE	E	SE	S	SW	W	NW
0.000 - 1.523	6.3	5.7	5.7	6.4	8.7	9.6	8.3	6.6
1.524 - 3.047	6.9	6.6	6.6	7.0	9.2	10.1	8.7	7.4
3.048 – 4.571	7.3	7.1	7.1	7.5	9.5	10.3	9.2	7.9
4.572 – 6.095	7.8	7.6	7.6	8.0	9.7	10.4	9.6	8.4
6.096 – 7.619	8.3	8.2	8.2	8.5	9.9	10.5	10.0	8.9
7.620 - 9.143						10.6	10.3	
9.144 – 10.667						10.8	10.6	
10.668 – 12.192						11.0	10.9	


Wave Exceedance Data for fatigue Analysis

Wave Height (m)	Cumulative numbers of Wave Exceeding a specified Wave Height in one year & Direction from:							
	N-DIR	NE-DIR	E-DIR	SE-DIR	S-DIR	SW-DIR	W-DIR	NW-DIR
0	1,190,038	184,866	92,433	77,627	86,007	585,669	923,280	1,142,884
1.524	49,065	10,832	5,327	5,747	12,639	208,515	215,658	64,041
3.048	1,925	767	342	427	1,207	37,162	31,560	3,337
4.572	67	48	20	27	100	5,830	4,053	150
6.096	3	3	1	2	8	866	492	6
7.620	0	0	0	0	0	126	59	0
9.144	0	0	0	0	0	18	7	0
10.668	0	0	0	0	0	2	1	0
12.192	0	0	0	0	0	0	0	0

Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for **All Directions**

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	4	0	0	0	0	0	0	4
2.5-3.4	23	7	1	0	0	0	0	31
3.5-4.4	86	26	7	3	1	0	0	123
4.5-5.4	110	64	26	10	2	1	0	213
5.5-6.4	108	64	31	18	9	4	0	234
6.5-7.4	52	57	29	19	12	7	0	176
7.5-8.4	17	16	15	14	10	8	0	80
8.5-9.4	10	8	7	6	5	4	0	40
9.5-10.4	9	6	4	4	3	1	0	27


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10.5-11.4	7	5	3	3	2	1	0	21
11.5-12.4	5	4	3	2	2	1	0	17
12.5-13.4	4	4	2	2	1	0	0	13
13.5-14.4	4	3	1	1	1	0	0	10
14.5-15.4	3	2	1	1	0	0	0	7
15.5 Plus	1	1	1	1	0	0	0	4
Total	443	267	131	84	48	27	0	1000

Average percentage occurrence of significant wave height: Annual

Direction	Significant Wave Height (m)							Total
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	
N	9	2.3	0.2	0	0	0	0	11.5
NE	8	2	0.1	0	0	0	0	10.1
E	2.6	0.7	0	0	0	0	0	3.3
SE	1.2	0.5	0	0	0	0	0	1.7
S	0.7	1.1	0.9	0.7	0.4	0.2	0	4
SW	2.3	5.3	5.3	4.4	2.7	1.6	0	21.6
W	7.5	10.2	6	3.3	1.7	0.9	0	29.6
NW	13	4.6	0.6	0	0	0	0	18.2
Total	44.3	26.7	13.1	8.4	4.8	2.7	0	100

Direction	Percentage Occurrence
N	11.5
NE	10.1
E	3.3
SE	1.7
S	4
SW	21.6
W	29.6
NW	18.2
Total	100

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D. Daman Field

Extreme Storm Parameters (100 years)


*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (Km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	4.27	0.15	12.50	11.70	0.701	1.036	1.189	1.372	1.524	1.676	149.67
North East	4.27	0.24	12.95	11.90	0.762	1.128	1.311	1.494	1.676	1.859	149.67
East	4.27	0.09	12.07	11.60	0.640	0.975	1.128	1.311	1.463	1.615	149.67
South East	4.27	0.24	12.86	11.80	0.549	0.853	1.006	1.128	1.280	1.402	149.67
South	4.27	1.49	17.50	14.40	0.701	1.036	1.189	1.372	1.524	1.676	149.67
South West	4.27	1.46	16.89	14.00	0.732	1.097	1.280	1.433	1.615	1.768	149.67
West	4.27	1.43	16.25	13.60	0.671	1.006	1.158	1.341	1.494	1.646	149.67
North West	4.27	0.15	12.41	11.70	0.610	0.914	1.067	1.219	1.341	1.494	149.67

Operating Storm Parameters (1 year)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
All Directions	4.267	0.884	9.754	10.20	0.579	0.884	1.006	1.158	1.280	1.402	80.47

Environmental Parameters for Installation Condition

Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.36	4.00	7.8	0.701	1.46	48.27

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Environmental Parameters for Fatigue Analysis

Deterministic Fatigue

Recommended Wave Period for Specified Wave Height Categories

Wave Height (m)		Wave Period in Sec (Direction from)							
		N-Dir	NE-Dir	E-Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	5	5	5	5	6.1	6.3	6.3	5.7
0.61	1.21	5.4	5.4	5.4	5.4	6.5	6.7	6.7	6.1
1.22	1.82	5.7	5.7	5.6	5.7	6.8	7.1	7.1	6.4
1.83	2.43	6	6	5.9	6	7.1	7.4	7.4	6.7
2.44	3.04	6.3	6.3	6.2	6.3	7.4	7.8	7.8	7
3.05	3.65	6.6	6.6	6.5	6.6	7.7	8.2	8.1	7.2
3.66	4.26	6.9	6.9	6.8	6.9	8	8.6	8.5	7.4
4.27	4.87	7.2	7.2	7.1	7.2	8.2	8.9	8.8	7.6
4.88	5.48	7.5	7.6	7.4	7.6	8.4	9.1	9	7.8
5.49	6.09					8.6	9.3	9.3	8.1
6.10	7.61					8.8	9.6	9.6	8.4
7.62	9.13					9	9.8	9.8	
9.14	10.65						10.1	10.1	

Number of Waves in 1 Year in selected wave height categories

Wave Height (m)		N-Dir	NE-Dir	E-Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	372496	324740	98695	54123	108246	662216	955119	608092
0.61	1.21	147351	128460	39042	21410	42820	261957	377824	240547
1.22	1.82	56042	48857	14849	8143	16286	99632	143700	91489
1.83	2.43	21315	18583	5648	3097	6194	37893	54653	34796
2.44	3.04	8107	7067	2148	1178	2356	14412	20787	13234
3.05	3.65	3084	2688	817	448	896	5481	7905	5034
3.66	4.26	1292	1057	391	195	325	1985	2864	1914
4.27	4.87	560	543	102	64	88	544	783	1128
4.88	5.48	40	50	8	16	81	494	714	47
5.49	6.09	0	0	0	0	35	212	305	0
6.10	7.61	0	0	0	0	20	114	174	0
7.62	9.13	0	0	0	0	1	14	12	0
9.14	10.65	0	0	0	0	0	2	1	0



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Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for **All Directions**

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	2	0	0	0	0	0	0	2
2.5-3.4	18	7	1	0	0	0	0	26
3.5-4.4	68	29	8	3	1	0	0	109
4.5-5.4	87	72	31	11	3	2	0	206
5.5-6.4	85	72	36	20	11	7	0	231
6.5-7.4	41	64	34	21	14	12	1	187
7.5-8.4	13	18	17	15	13	12	1	89
8.5-9.4	8	9	8	7	6	8	1	47
9.5-10.4	7	7	5	4	3	2	0	28
10.5-11.4	6	5	3	3	2	1	0	20
11.5-12.4	4	5	3	2	2	1	0	17
12.5-13.4	3	4	3	2	1	1	0	14
13.5-14.4	3	4	2	1	1	1	0	12
14.5-15.4	2	2	1	1	1	1	0	8
15.5 Plus	1	1	1	1	0	0	0	4
Total	348	299	153	91	58	48	3	1000

Direction	Percentage Occurrence
N	11.7
NE	10.2
E	3.1
SE	1.7
S	3.4
SW	20.8
W	30
NW	19.1
Total	100



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E. Ratna Field


Extreme Storm Parameters (100 years)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	4.267	0.152	15.545	13.10	0.579	1.036	1.250	1.490	1.710	1.920	149.67
North East	4.267	0.030	12.131	11.50	0.549	1.006	1.220	1.400	1.620	1.798	149.67
East	4.267	0.000	11.765	11.30	0.488	0.884	1.070	1.250	1.400	1.585	149.67
South East	4.267	0.061	12.680	11.70	0.518	0.914	1.100	1.280	1.430	1.615	149.67
South	4.267	1.341	17.831	14.40	0.549	0.975	1.160	1.340	1.490	1.676	149.67
South West	4.267	1.311	17.130	14.10	0.518	0.914	1.070	1.250	1.400	1.554	149.67
West	4.267	1.250	16.429	13.80	0.488	0.884	1.040	1.190	1.340	1.494	149.67
North West	4.267	1.280	16.703	13.90	0.549	1.006	1.220	1.400	1.620	1.798	149.67

Operating Storm Parameters (1 year)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	4.267	0.091	6.309	8.20	0.488	0.884	1.036	1.189	1.311	1.463	69.20
North East	4.267	0.030	4.938	7.50	0.457	0.823	0.975	1.097	1.250	1.372	69.20
East	4.267	0.000	4.785	7.40	0.396	0.732	0.853	0.975	1.067	1.189	69.20
South East	4.267	0.061	5.151	7.60	0.427	0.762	0.884	1.006	1.097	1.219	69.20
South	4.267	0.640	8.443	9.10	0.457	0.792	0.914	1.036	1.158	1.280	69.20
South West	4.267	0.732	10.272	10.30	0.427	0.792	0.914	1.036	1.158	1.280	80.47
West	4.267	0.701	9.815	10.00	0.396	0.732	0.853	0.975	1.067	1.189	77.25
North West	4.267	0.762	6.797	8.50	0.457	0.823	0.975	1.128	1.250	1.402	69.20

Environmental Parameters for Installation Condition

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Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.39	3.6	7.8	0.426	0.701	48.27

Environmental Parameters for Fatigue Analysis

Deterministic Fatigue

Recommended Wave Period for Specified Wave Height Categories

Wave Height (m)	Wave Period in Sec (Direction from)							
	North	NE	East	SE	South	SW	West	NW
0.000 - 1.523	6.3	5.7	5.7	6.4	8.7	9.6	8.3	6.6
1.524 - 3.047	6.9	6.6	6.6	7.0	9.2	10.1	8.7	7.4
3.048 – 4.571	7.3	7.1	7.1	7.5	9.5	10.3	9.2	7.9
4.572 – 6.095	7.8	7.6	7.6	8.0	9.7	10.4	9.6	8.4
6.096 – 7.619	8.3	8.2	8.2	8.5	9.9	10.5	10.0	8.9
7.620 - 9.143						10.6	10.3	
9.144 – 10.667						10.8	10.6	
10.668 – 12.192						11.0	10.9	


Wave Exceedance Data for fatigue Analysis

Wave Height (m)	Cumulative numbers of Wave Exceeding a specified Wave Height in one year & Direction from:							
	North	NE	East	SE	South	SW	West	NW
0	1,190,038	184,866	92,433	77,627	86,007	585,669	923,280	1,142,884
1.524	49,065	10,832	5,327	5,747	12,639	208,515	215,658	64,041
3.048	1,925	767	342	427	1,207	37,162	31,560	3,337
4.572	67	48	20	27	100	5,830	4,053	150
6.096	3	3	1	2	8	866	492	6
7.620	0	0	0	0	0	126	59	0
9.144	0	0	0	0	0	18	7	0
10.668	0	0	0	0	0	2	1	0
12.192	0	0	0	0	0	0	0	0

Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for All Directions

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	2	0	0	0	0	0	0	2
2.5-3.4	15	8	2	0	0	0	0	25
3.5-4.4	57	29	9	3	1	0	0	99


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4.5-5.4	73	73	36	13	3	2	0	200
5.5-6.4	72	73	43	24	13	7	0	232
6.5-7.4	35	65	41	24	14	13	1	193
7.5-8.4	11	19	19	18	13	14	1	95
8.5-9.4	7	9	9	8	7	9	1	50
9.5-10.4	5	7	5	4	4	2	0	27
10.5-11.4	4	6	4	3	2	1	0	20
11.5-12.4	3	5	4	3	2	1	0	18
12.5-13.4	3	4	3	2	2	1	0	15
13.5-14.4	2	3	2	2	1	1	0	11
14.5-15.4	2	2	1	1	1	1	0	8
15.5 Plus	1	1	1	1	1	0	0	5
Total	292	304	179	106	64	52	3	1000

Average percentage occurrence of Significant wave height: Annual

Direction	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
N	8.8	8.1	3.5	1	0.2	0.1	0	21.7
NE	4.5	2.4	0.4	0	0	0	0	7.3
E	1.8	0.9	0.1	0	0	0	0	2.8
SE	0.8	0.4	0.1	0	0	0	0	1.3
S	0.3	0.7	0.5	0.3	0	0	0	1.8
SW	0.8	2.5	3	2.8	2.3	1.9	0.1	13.4
W	2.4	5.9	5.7	4.8	3.4	3	0.2	25.4
NW	9.8	9.5	4.6	1.7	0.5	0.2	0	26.3
Total	29.2	30.4	17.9	10.6	6.4	5.2	0.3	100

Direction	Percentage Occurrence
N	21.7
NE	7.3
E	2.8
SE	1.3
S	1.8
SW	13.4
W	25.4
NW	26.3
Total	100

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F. D1 / NBP Field

Extreme Storm Parameters (100 years)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	2.99	0.183	15.850	13.10	0.427	0.853	1.036	1.219	1.402	1.585	149.67
North East	2.99	0.183	15.545	12.90	0.396	0.792	0.975	1.158	1.311	1.494	149.67
East	2.99	0.122	15.088	12.70	0.335	0.671	0.823	1.006	1.158	1.311	149.67
South East	2.99	0.183	16.002	13.20	0.366	0.732	0.884	1.036	1.189	1.341	149.67
South	2.99	1.097	19.507	14.80	0.366	0.762	0.914	1.067	1.219	1.372	149.67
South West	2.99	1.067	18.745	14.40	0.366	0.732	0.884	1.036	1.189	1.341	149.67
West	2.99	1.006	17.983	14.10	0.335	0.671	0.823	1.006	1.158	1.311	149.67
North West	2.99	1.036	18.288	14.30	0.396	0.792	0.975	1.158	1.311	1.494	149.67

Operating Storm Parameters (1 year)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (Km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	2.99	0.122	6.492	8.20	0.335	0.671	0.823	0.945	1.097	1.219	69.20
North East	2.99	0.122	6.340	8.10	0.305	0.610	0.762	0.884	1.036	1.158	69.20
East	2.99	0.091	6.157	8.10	0.244	0.488	0.610	0.762	0.884	1.006	69.20
South East	2.99	0.122	6.553	8.20	0.274	0.549	0.671	0.792	0.914	1.036	69.20
South	2.99	0.518	9.266	9.00	0.305	0.610	0.732	0.853	0.945	1.067	69.20
South West	2.99	0.610	11.247	8.80	0.305	0.640	0.762	0.884	0.975	1.097	80.47
West	2.99	0.579	10.759	8.60	0.305	0.610	0.732	0.853	0.945	1.067	77.25
North West	2.99	0.732	7.468	8.70	0.305	0.610	0.762	0.884	1.036	1.158	69.20

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Environmental Parameters for Installation Condition

Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.36	3.6	8.3	0.426	0.701	48.27

Deterministic Fatigue

Recommended Wave Period for Specified Wave Height Categories

Wave Height (m)	Wave Period in Sec (Direction from)							
	North	NE	East	SE	South	SW	West	NW
0.000 - 1.523	6.3	5.7	5.7	6.4	8.7	9.6	8.3	6.6
1.524 - 3.047	6.9	6.6	6.6	7.0	9.2	10.1	8.7	7.4
3.048 – 4.571	7.3	7.1	7.1	7.5	9.5	10.3	9.2	7.9
4.572 – 6.095	7.8	7.6	7.6	8.0	9.7	10.4	9.6	8.4
6.096 – 7.619	8.3	8.2	8.2	8.5	9.9	10.5	10.0	8.9
7.620 - 9.143						10.6	10.3	
9.144 – 10.667						10.8	10.6	
10.668 – 12.192						11.0	10.9	


Wave Exceedence Data for fatigue Analysis

Wave Height (m)	Cumulative numbers of Wave Exceeding a specified Wave Height in one year & Direction from:							
	N-DIR	NE-DIR	E-DIR	SE-DIR	S-DIR	SW-DIR	W-DIR	NW-DIR
0	1,190,038	184,866	92,433	77,627	86,007	585,669	923,280	1,142,884
1.524	49,065	10,832	5,327	5,747	12,639	208,515	215,658	64,041
3.048	1,925	767	342	427	1,207	37,162	31,560	3,337
4.572	67	48	20	27	100	5,830	4,053	150
6.096	3	3	1	2	8	866	492	6
7.620	0	0	0	0	0	126	59	0
9.144	0	0	0	0	0	18	7	0
10.668	0	0	0	0	0	2	1	0
12.192	0	0	0	0	0	0	0	0

Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for All Directions

Mean wave period (sec)	Significant Wave Height (m)							Total
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	
0.0-2.4	2	0	0	0	0	0	0	2


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2.5-3.4	13	8	2	0	0	0	0	23
3.5-4.4	51	30	9	3	1	0	0	94
4.5-5.4	66	74	37	13	4	2	0	196
5.5-6.4	65	73	43	24	13	9	0	227
6.5-7.4	32	66	42	25	15	17	1	198
7.5-8.4	10	19	20	19	14	17	2	101
8.5-9.4	6	9	9	8	7	12	1	52
9.5-10.4	5	7	5	4	4	3	1	29
10.5-11.4	4	6	4	3	3	2	0	22
11.5-12.4	3	5	4	3	2	1	0	18
12.5-13.4	2	4	3	2	2	1	0	14
13.5-14.4	2	3	2	2	1	1	0	11
14.5-15.4	2	2	1	1	1	1	0	8
15.5 Plus	1	1	1	1	1	0	0	5
Total	264	307	182	108	68	66	5	1000

Average percentage occurrence of Significant wave height: Annual

Direction	Significant Wave Height (m)							Total
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.02	3.04–4.56	4.57 plus	
N	5.8	4.7	1.6	0.4	0.1	0	0	12.6
NE	4.9	3.8	1.3	0.3	0	0	0	10.3
E	1.4	1	0.3	0.1	0	0	0	2.8
SE	0.7	0.5	0.3	0.1	0	0	0	1.6
S	0.4	0.7	0.6	0.4	0.1	0	0	2.2
SW	1.4	3.6	3.9	3.6	3.1	3.3	0.3	19.2
W	4.5	8.7	6.5	4.5	3.1	3.2	0.2	30.7
NW	7.4	7.5	3.7	1.4	0.5	0.1	0	20.6
Total	26.5	30.5	18.2	10.8	6.9	6.6	0.5	100

Direction	Percentage Occurrence
N	12.6
NE	10.3
E	2.8
SE	1.6
S	2.2
SW	19.2
W	30.7

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NW	20.6
Total	100


G. GK Field

Extreme Storm Parameters (100 years)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	3.688	0.091	12.710	11.80	0.640	1.036	1.250	1.433	1.646	1.829	149.67
North East	3.688	0.030	12.009	11.30	0.610	0.975	1.158	1.341	1.524	1.707	149.67
East	3.688	0.000	10.759	10.60	0.549	0.884	1.036	1.219	1.372	1.524	149.67
South East	3.688	1.341	17.313	14.20	0.579	0.914	1.067	1.250	1.402	1.554	149.67
South	3.688	1.402	17.648	14.30	0.610	0.945	1.097	1.280	1.433	1.585	149.67
South West	3.688	1.372	16.947	14.00	0.549	0.884	1.036	1.189	1.341	1.494	149.67
West	3.688	1.311	16.246	13.70	0.518	0.853	1.006	1.158	1.280	1.433	149.67
North West	3.688	1.341	16.459	13.80	0.610	0.975	1.158	1.341	1.524	1.707	149.67

Operating Storm Parameters (1 year)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	3.688	0.061	5.182	7.6	0.488	0.884	1.036	1.189	1.311	1.463	69.20

<div>ओएनजीसी</div> <div></div> <div>ONGC</div>			Offshore Design Section Engineering Services ISO – 9001:2008			STRUCTURAL DESIGN CRITERIA PART-I				VOL-II SECTION 3.4		REV.14 SHEET 106 of 116	
North East	3.688	0.030	4.877	7.5	0.457	0.823	0.975	1.097	1.250	1.372	69.20		
East	3.688	0.000	4.389	7.2	0.427	0.762	0.884	1.006	1.097	1.219	69.20		
South East	3.688	0.823	7.071	8.7	0.457	0.792	0.914	1.036	1.128	1.250	69.20		
South	3.688	0.701	8.352	9.1	0.457	0.792	0.914	1.036	1.158	1.280	69.20		
South West	3.688	0.792	10.119	10.3	0.427	0.792	0.914	1.036	1.158	1.280	80.47		
West	3.688	0.762	9.662	10.2	0.396	0.732	0.853	0.975	1.067	1.189	77.25		
North West	3.688	0.823	6.706	8.5	0.457	0.823	0.975	1.097	1.250	1.372	69.20		

Environmental Parameters for Installation Condition

Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.36	4.00	7.8	0.701	1.46	48.27

Environmental Parameters for Fatigue Analysis

Deterministic Fatigue

Recommended Wave Period for Specified Wave Height Categories

Wave Height (m)	Wave Period in Sec (Direction from)							
	N-DIR	NE-DIR	E-DIR	SE-DIR	S-DIR	SW-DIR	W-DIR	NW-DIR
0.000 - 1.523	6.3	5.7	5.7	6.4	8.7	9.6	8.3	6.6
1.524 - 3.047	6.9	6.6	6.6	7.0	9.2	10.1	8.7	7.4
3.048 – 4.571	7.3	7.1	7.1	7.5	9.5	10.3	9.2	7.9
4.572 – 6.095	7.8	7.6	7.6	8.0	9.7	10.4	9.6	8.4
6.096 – 7.619	8.3	8.2	8.2	8.5	9.9	10.5	10.0	8.9
7.620 - 9.143						10.6	10.3	
9.144 – 10.667						10.8	10.6	
10.668 – 12.192						11.0	10.9	

Wave Exceedance Data for fatigue Analysis



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Wave Height (m)	Cumulative numbers of Wave Exceeding a specified Wave Height in one year & Direction from:							
	North	NE	East	SE	South	SW	West	NW
0	1,190,038	184,866	92,433	77,627	86,007	585,669	923,280	1,142,884
1.524	49,065	10,832	5,327	5,747	12,639	208,515	215,658	64,041
3.048	1,925	767	342	427	1,207	37,162	31,560	3,337
4.572	67	48	20	27	100	5,830	4,053	150
6.096	3	3	1	2	8	866	492	6
7.620	0	0	0	0	0	126	59	0
9.144	0	0	0	0	0	18	7	0
10.668	0	0	0	0	0	2	1	0
12.192	0	0	0	0	0	0	0	0


Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for All Directions

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	2	0	0	0	0	0	0	2
2.5-3.4	12	7	2	0	0	0	0	21
3.5-4.4	46	26	10	4	1	0	0	87
4.5-5.4	60	67	38	16	5	2	0	188
5.5-6.4	58	66	44	31	17	10	0	226
6.5-7.4	28	58	44	32	21	19	1	203
7.5-8.4	9	17	21	23	20	20	1	111
8.5-9.4	5	8	9	9	9	14	1	55
9.5-10.4	4	6	6	5	4	3	1	29
10.5-11.4	3	5	4	4	3	2	0	21
11.5-12.4	3	4	4	3	2	2	0	18
12.5-13.4	2	4	3	3	2	1	0	15
13.5-14.4	2	2	2	2	1	1	0	10
14.5-15.4	2	2	2	1	1	1	0	9
15.5 Plus	1	1	1	1	1	0	0	5
Total	237	273	190	134	87	75	4	1000

Average percentage occurrence of significant wave height: Annual

Direction	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
N	5.3	3.6	0.9	0.1	0	0	0	9.9
NE	5.8	3.5	0.7	0.1	0	0	0	10.1

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E	1.6	0.8	0.2	0	0	0	0	2.6
SE	0.4	0.5	0.3	0.1	0	0	0	1.3
S	0.4	0.8	0.9	0.7	0.3	0.2	0	3.3
SW	1.2	4.3	5.8	5.7	4.5	4.1	0.3	25.9
W	2.9	7.5	7.1	5.5	3.6	3.1	0.1	29.8
NW	6.1	6.3	3.1	1.2	0.3	0.1	0	17.1
Total	23.7	27.3	19	13.4	8.7	7.5	0.4	100

Direction	Percentage Occurrence
N	9.9
NE	10.1
E	2.6
SE	1.3
S	3.3
SW	25.9
W	29.8
NW	17.1
Total	100

H. MB-OSN Field

Extreme Storm Parameters (100 years)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	3.200	0.000	10.272	11.00	0.579	0.853	1.006	1.158	1.311	1.463	149.67
North East	3.200	0.152	12.436	11.70	0.701	1.036	1.219	1.372	1.554	1.707	149.67
East	3.200	0.335	13.259	12.00	0.671	0.975	1.128	1.311	1.463	1.615	149.67
South East	3.200	0.610	14.112	12.30	0.610	0.884	1.036	1.189	1.341	1.494	149.67
South	3.200	1.554	17.435	14.40	0.640	0.945	1.097	1.280	1.433	1.585	149.67
South West	3.200	1.524	16.825	14.00	0.671	0.975	1.158	1.311	1.494	1.646	149.67
West	3.200	1.494	16.215	13.60	0.610	0.914	1.067	1.219	1.372	1.524	149.67
North West	3.200	0.000	10.638	11.10	0.549	0.823	0.975	1.097	1.250	1.372	149.67

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Operating Storm Parameters (1 year)

*Direction (From)	Tide (m)		Max. Wave		Current (m/sec) (Y is the depth of water and currents are measured from bottom)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-Hour average
All Directions	3.2	0.9	9.7	10.2	0.5	0.8	0.9	1.1	1.2	1.3	80.47

Environmental Parameters for Installation Condition


Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.36	4.00	7.8	0.701	1.46	48.27

Environmental Parameters for Fatigue Analysis

Deterministic Fatigue

Recommended Wave Period for Specified Wave Height Categories

Wave Height (m)		Wave Period in Sec (Direction from)							
		N-Dir	NE-Dir	E-Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	5	5	5	5	6.2	6.4	6.4	5.4
0.61	1.21	5.4	5.4	5.4	5.5	6.5	6.8	6.8	5.8
1.22	1.82	5.7	5.7	5.7	5.8	6.8	7.2	7.2	6.1
1.83	2.43	6	6	6	6.1	7.1	7.6	7.6	6.4
2.44	3.04	6.3	6.3	6.3	6.4	7.4	7.9	7.9	6.7
3.05	3.65	6.6	6.6	6.6	6.7	7.7	8.1	8.1	6.9
3.66	4.26	6.9	6.9	6.9	7	7.9	8.3	8.3	7
4.27	4.87		7.2	7.2	7.3	8.1	8.5	8.5	7.1
4.88	5.48		7.4	7.5	7.6	8.3	8.7	8.7	
5.49	6.09					8.5	9	9	
6.10	7.61					8.7	9.3	9.3	
7.62	9.13					8.9	9.7	9.7	

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9.14	10.65						10.1	10.1	
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Number of Waves in 1 Year in Selected wave height categories

Wave Height (m)		N-Dir	NE-Dir	E- Dir	SE-Dir	S-Dir	SW- Dir	W-Dir	NW- Dir
0.00	0.60	385957	325351	95692	54225	89313	644324	953727	641135
0.61	1.21	152221	128319	37741	21387	35224	254122	376150	252863
1.22	1.82	57720	48656	14310	8109	13357	96359	142630	95882
1.83	2.43	21886	18450	5427	3075	5065	36537	54083	36357
2.44	3.04	8239	6945	2042	1157	1906	13754	20358	14186
3.05	3.65	4629	2234	657	373	613	4424	6549	6527
3.66	4.26	500	1640	484	262	292	2106	3116	1462
4.27	4.87	0	377	102	59	168	1210	1792	31
4.88	5.48	0	73	29	20	69	495	732	0
5.49	6.09	0	0	0	7	28	203	300	0
6.10	7.61	0	0	0	0	16	109	174	0
7.62	9.13	0	0	0	0	1	14	11	0
9.14	10.65	0	0	0	0	0	2	1	0

Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for **All Directions**

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	3	0	0	0	0	0	0	3
2.5-3.4	19	7	1	0	0	0	0	27
3.5-4.4	74	27	7	3	1	0	0	112
4.5-5.4	94	68	28	10	3	2	0	205
5.5-6.4	93	69	33	19	12	7	0	233
6.5-7.4	47	61	31	19	14	12	0	184
7.5-8.4	15	17	16	15	13	12	1	89
8.5-9.4	9	8	7	7	6	9	1	47
9.5-10.4	7	6	5	4	3	2	0	27


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10.5-11.4	6	5	3	3	2	1	0	20
11.5-12.4	4	4	3	2	2	1	0	16
12.5-13.4	3	4	3	2	1	1	0	14
13.5-14.4	3	4	1	1	1	1	0	11
14.5-15.4	2	2	1	1	1	1	0	8
15.5 Plus	1	1	1	1	0	0	0	4
Total	380	283	140	87	59	49	2	1000

Average percentage occurrence of significant wave height: **Annual**

Direction	Significant Wave Height (m)							Total
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	
N	8.5	3.2	0.4	0	0	0	0	12.1
NE	6.1	3.4	0.7	0	0	0	0	10.2
E	1.6	1.1	0.3	0	0	0	0	3
SE	0.8	0.6	0.2	0.1	0	0	0	1.7
S	0.5	0.8	0.6	0.4	0.3	0.2	0	2.8
SW	1.7	4.3	4.5	4	3	2.6	0.1	20.2
W	5.5	9.1	6.4	4.1	2.6	2.1	0.1	29.9
NW	13.3	5.8	0.9	0.1	0	0	0	20.1
Total	38	28.3	14	8.7	5.9	4.9	0.2	100

Direction	Percentage Occurrence
N	12.1
NE	10.2
E	3.0
SE	1.7
S	2.8
SW	20.2
W	29.9
NW	20.1
Total	100

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I. Saurashtra Field

Extreme Storm Parameters (100 years)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	2.316	0.122	15.149	12.80	0.366	0.762	0.914	1.097	1.250	1.402	149.67
North East	2.316	0.030	12.984	11.40	0.335	0.671	0.823	0.975	1.097	1.250	149.67
East	2.316	0.061	14.143	12.10	0.366	0.732	0.884	1.067	1.219	1.372	149.67
South East	2.316	0.884	17.496	14.00	0.396	0.823	1.006	1.158	1.341	1.494	149.67
South	2.316	1.097	19.660	14.90	0.366	0.762	0.914	1.097	1.250	1.402	149.67
South West	2.316	1.067	19.202	14.70	0.366	0.701	0.853	1.006	1.128	1.280	149.67
West	2.316	1.036	18.745	14.50	0.366	0.762	0.945	1.097	1.280	1.433	149.67
North West	2.316	0.975	18.288	14.30	0.396	0.823	1.006	1.189	1.341	1.524	149.67

Operating Storm Parameters (1 year)

*Direction (From)	Tide (m)		(Max Wave)		Current (m/s)						Wind (km/hr)
	AT	Storm	Height (m)	Period (sec)	Bottom	Y-1/5	Y-2/5	Y-3/5	Y-4/5	Surface	1-hour average
North	2.316	0.091	6.096	8.30	0.305	0.610	0.732	0.884	1.006	1.128	69.20
North East	2.316	0.030	5.243	7.60	0.274	0.549	0.671	0.792	0.884	1.006	69.20
East	2.316	0.030	5.700	8.00	0.305	0.579	0.701	0.853	0.975	1.097	69.20
South East	2.316	0.671	7.620	8.90	0.335	0.640	0.792	0.914	1.067	1.189	69.20
South	2.316	0.518	9.144	9.60	0.305	0.610	0.732	0.884	1.006	1.128	69.20
South West	2.316	0.610	11.125	10.60	0.274	0.549	0.671	0.792	0.914	1.036	80.47
West	2.316	0.579	10.638	10.50	0.305	0.610	0.762	0.884	1.036	1.158	77.25
North West	2.316	0.701	7.285	8.60	0.366	0.671	0.823	0.945	1.097	1.219	69.20



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Environmental Parameters for Installation Condition

Tide (m)	Maximum wave Height (m)	Period (sec)	Current (m/s)		Wind (km/hr)
			Bottom	Surface	1 Minute Sustained
4.36	4.00	7.8	0.701	1.46	48.27

Environmental Parameters for Fatigue Analysis


Deterministic Fatigue

Recommended Wave Period for Specified Wave Height Categories

Wave Height (m)		Wave Period in Sec (Direction from)							
		N-Dir	NE-Dir	E- Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	5	5	5	5.6	6	6.4	6.4	5.6
0.61	1.21	5.4	5.4	5.4	5.9	6.3	6.7	6.7	5.9
1.22	1.82	5.8	5.8	5.8	6.2	6.6	7.1	7.1	6.2
1.83	2.43	6.2	6.2	6.2	6.5	6.9	7.4	7.4	6.5
2.44	3.04	6.5	6.5	6.5	6.8	7.2	7.7	7.7	6.8
3.05	3.65	6.8	6.8	6.8	7.1	7.5	8.1	8.1	7.1
3.66	4.26	7.1	7.1	7.1	7.4	7.9	8.5	8.5	7.4
4.27	4.87	7.4	7.4	7.4	7.7	8.3	8.8	8.8	7.7
4.88	5.48	7.7	7.6	7.7	8	8.6	9.1	9.1	8
5.49	6.09	8		8	8.3	8.9	9.4	9.4	8.3
6.10	7.61	8.3			8.6	9.2	9.6	9.6	8.5
7.62	9.13				8.9	9.5	9.9	9.8	
9.14	10.66						10.1	10.1	
10.67	12.18						10.5		

Number of Waves in 1 Year in Selected wave height categories

Wave Height (m)		N-Dir	NE-Dir	E- Dir	SE-Dir	S-Dir	SW-Dir	W-Dir	NW-Dir
0.00	0.60	445859	272795	82132	43999	61599	489861	730388	806653
0.61	1.21	198315	121338	36532	19571	27399	217883	324871	358793
1.22	1.82	84973	51990	15653	8385	11740	93359	139199	153734
1.83	2.43	36409	22276	6707	3593	5030	40001	59644	65872
2.44	3.04	15600	9545	2874	1540	2155	17140	25556	28224

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3.05	3.65	6685	4090	1231	659	924	7344	10950	12093
3.66	4.26	2826	1967	527	283	390	3106	4630	5114
4.27	4.87	1183	936	294	121	164	1298	1937	2140
4.88	5.48	898	163	92	52	66	529	789	871
5.49	6.09	102	0	10	22	29	232	345	742
6.10	7.61	2	0	0	15	34	289	437	200
7.62	9.13	0	0	0	2	8	42	66	0
9.14	10.66	0	0	0	0	1	8	5	0
10.67	12.18	0	0	0	0	0	2	0	0


Spectral Fatigue

Average Annual Occurrence of Mean Wave Period in Significant Wave Height for All Directions

Mean wave period (sec)	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
0.0-2.4	2	0	0	0	0	0	0	2
2.5-3.4	14	7	2	0	0	0	0	23
3.5-4.4	53	28	9	3	1	0	0	94
4.5-5.4	67	72	35	12	4	3	0	193
5.5-6.4	65	72	41	24	12	10	0	224
6.5-7.4	32	62	41	24	15	20	2	196
7.5-8.4	11	18	19	18	15	20	2	103
8.5-9.4	6	9	9	8	7	15	2	56
9.5-10.4	5	7	5	4	4	3	2	30
10.5-11.4	4	5	4	3	3	2	1	22
11.5-12.4	3	5	3	3	2	2	0	18
12.5-13.4	2	4	3	2	2	1	0	14
13.5-14.4	2	3	2	2	1	1	0	11
14.5-15.4	3	2	1	1	1	1	0	9
15.5 Plus	1	1	1	1	1	0	0	5
Total	270	295	175	105	68	78	9	1000

Average percentage occurrence of Significant wave height: Annual

Direction	Significant Wave Height (m)							
	0.00–0.60	0.61–1.21	1.22–1.82	1.83–2.43	2.44–3.04	3.05–4.56	4.57 plus	Total
N	4.3	3.8	1.5	0.3	0.1	0	0	10
NE	5.3	3.7	1	0.1	0	0	0	10.1
E	1.2	1	0.4	0.1	0	0	0	2.7
SE	0.5	0.5	0.2	0.1	0.1	0	0	1.4

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S	0.4	0.8	0.7	0.6	0.3	0.3	0	3.1
SW	1.1	3.5	4.8	5	4.4	5.2	0.6	24.6
W	2.7	6.5	6.3	5.2	3.8	4	0.4	28.9
NW	5.8	6.8	4	1.7	0.6	0.3	0	19.2
Total	21.3	26.6	18.9	13.1	9.3	9.8	1	100

Direction	Percentage Occurrence
N	15.2
NE	9.3
E	2.8
SE	1.5
S	2.1
SW	16.7
W	24.9
NW	27.5
Total	100

Notes for Extreme & Operating conditions:


1. Lowest Astronomical Tide (LAT) :


Mumbai High, B&S , Neelam & Heera Fields	(-) 0.183 m
Tapti, Ratna, GK, MB-OSN Fields	(-) 0.091 m
Daman Field	(-) 0.122 m
D1/NBP, Saurashtra Field	(-) 0.061 m

2. Wave Kinematics Factor =0.880 (For In-place Analysis)

The Contractor shall determine the significant wave heights and apparent wave Periods if required for the work.

3. The above table contains the design environmental conditions for the maximum operating storm, the 100 years extreme storm. The wind speeds are at a reference elevation of + 10.00 M above Mean Sea Level (MSL)

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<p>4. Tidal parameter & Environmental Parameters indicated are based on Indian Spring Low Water (ISLW).</p> <p>5. During Pre-Engineering Survey, Chart Datum (CD) as per international practice shall be established.</p> <p>6. “Direction from/Direction” in the Tables – Indicates the Direction from which wind blows, current blows & wave approach.</p> <p><u>Notes for Installation conditions:</u></p> <ol style="list-style-type: none"> Contractor shall select barge which is stable to work at the stated environmental parameters so as to minimize waiting on weather. Wave kinematics factor equal to 1.0 and current blockage 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. Contractor shall obtain Installation Environmental Parameter / Data for Installation of Topside by Float Over method <p><u>General Notes for all Environmental loads:</u></p> <ol style="list-style-type: none"> Wave directions are directions from which wave approaches the platform. In case the selected wave / wind/current approach direction is within +10 Degrees of the standard approach directions for which the environmental data has been furnished, such data shall be directly used for the selected wave approach direction. For other Cases, the data shall be linearly interpolated between the two adjacent directions for which data shall be furnished. Still water depth shall be taken as $CD + (LAT) + SS + (50\% \text{ of Astronomical Tide})$ for storm environment. For Earthquake condition still water level shall be considered as $CD + (LAT) + (50\% \text{ of Astronomical Tide})$. Wave Kinematics Factor = 1.00 (for Fatigue) 				

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STRUCTURAL

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(PART - II)

FOR

(WSSRP-2)

**OIL AND NATURAL GAS CORPORATION LIMITED
INDIA**

Discipline Engineer	Discipline Head	Group Head	3	10.10.2023	0
Prepared by	Reviewed by	Approved by	No of Pages	Date	Revision

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PROJECT SPECIFIC REQUIREMENT

1. TIDE, WAVE, CURRENT & WIND PARAMETERS FOR DESIGN

S.No.	Platform	Applicable Field	Reference in DC 3.4 Part-I
1.	ICP	Mumbai High Field (North & South)	Annexure-13A
2.	ICW	Mumbai High Field (North & South)	Annexure-13A
3.	NC	Mumbai High Field (North & South)	Annexure-13A
4.	SHW	Mumbai High Field (North & South)	Annexure-13A
5.	SHD	Mumbai High Field (North & South)	Annexure-13A
6.	SHP	Mumbai High Field (North & South)	Annexure-13A
7.	SHG	Mumbai High Field (North & South)	Annexure-13A
8.	BHS	Mumbai High Field (North & South)	Annexure-13A
9.	RS-21	Mumbai High Field (North & South)	Annexure-13A
10.	NLP	Neelam & Heera Field	Annexure-13B
11.	HRA	Neelam & Heera Field	Annexure-13B

2. Project Specific Design requirement:

Following project specific requirements shall be met by the conceptual design/scheme proposed by the Contractor/Bidder in bid:

a) Deck Extension/ Modification/ Strengthening of Topside Members:

As per Structural Design Criteria part-I of section-3 of vol.II & Scope of Work.

b) Underwater Repair:

Underwater repair of jacket members & joints at SHP Jacket shall be carried out as per Structural Design Criteria part-III of section-3 of vol.II & Scope of Work.

3. Drawings.

Contractor shall collect all structural and other related details for the purpose of designing deck extension and modification of platform topside during pre-engineering survey.



STRUCTURAL
DESIGN CRITERIAL FOR UNDER WATER REPAIR
Section-3.4 (Part III)

GG	AKS	RKJ	Issued For Bid	12	19.11.2018	2
DSR	SKJ	RKJ	Issued For Bid	9	11.05.2016	1
SK/KKD	SKJ	RMK	Issued For Bid	11	31.01.2015	0
Prepared by	Reviewed by	Approved by	Remarks	No of Pages	Date	Rev



DESIGN CRITERIA FOR UNDER WATER REPAIR OF JACKET STRUCTURAL MEMBERS AND JOINTS

CONTENTS UNDER DESIGN CRITERIA –PART III

- 1.0 GENERAL REQUIREMENT FOR UNDER WATER REPAIR
- 2.0 CODES & STANDARDS
- 3.0 STRUCTURAL ANALYSIS FOR UNDER WATER JACKET REPAIR FOR MEMBER(S) & JOINT(S)
 - 3.1 INPLACE, & PUSHOVER ANALYSIS TO WORK OUT DESIGN FORCES
 - 3.2 FATIGUE ANALYSIS
 - 3.3 LOCAL DESIGN
 - 3.4 CLAMP BOLT, FLANGE, AND STIFFENER DESIGN
- 4.0 REPAIR METHOD:
 - 4.1 DOUBLER PLATES
 - 4.2 MECHANICAL CLAMPS
 - 4.3 GROUTED CLAMP DESIGN
- 5.0 STRENGTH FORMULATION FOR GROUTED CONNECTION (HSE PILE/SLEEVE CONNECTIONS)
- 6.0 SAFETY FACTORS
- 7.0 MATERIAL FOR GROUTING
 - 7.1 GROUT (CEMENTITIOUS) MATERIAL
 - 7.2 GENERAL REQUIREMENTS OF CEMENTITIOUS MATERIAL
 - 7.2.1 EX-STOCK CEMENTITIOUS MATERIAL
 - 7.2.2 MANUFACTURER'S CERTIFICATE OF CEMENTITIOUS MATERIAL
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- 8.0 BOLT MATERIAL
- 9.0 GUIDELINES FOR REPAIR OF JACKET WALKWAY MEMBERS
- 10.0 INSTALLATION/REPAIR PROCEDURE
- 11.0 AS-BUILT DOCUMENTATION



DESIGN CRITERIA FOR UNDER WATER REPAIR OF JACKET STRUCTURAL MEMBERS AND JOINTS

1.0 GENERAL REQUIREMENT FOR UNDER WATER REPAIR

Underwater repair of Jacket Structural member(s) & Joint(s) shall be carried out at Platforms specified in the Scope of Work (Section – 2 of Bid Document) to strengthen the Structural member(s) and joint(s). This Document shall be read along with Scope of Work (Section – 2 of Bid Document), Structural Design Criteria Part – I, Part – II, and Material Spec. 6001F.

LSTK Contractor's scope of work includes pre engineering Survey, detail engineering & design & drawings, procurement of various material, supply of manpower (skilled & unskilled) at various stages of work, fabrication, NDT, load-out, transportation, suitable marine spread, Tools & plants, Diving Equipment/ Spreads with skilled divers and installation of clamps on member(s) & Joint(s) & grouting proposed for Under water repair as described in following Clauses & sub-clauses. The Contractor's scope of work shall include but not be limited to the following:

- a) Design, procurement, manpower, equipment, steel and non-steel material, fabrication, Load Out, Transportation and underwater repair at offshore site.
- b) Contractor shall mobilise suitable marine spread for carrying out the scope of work including mobilization, demobilization, obtaining required clearances from Statutory Authority, Government Authority, Third Party Inspection Agency, Marine Warranty Surveyor & approvals from Company.
- c) Envisaged under water repair methodology is by using grouted clamp having multiple segments, which are placed around the existing tubular(s) / joint(s). These segments are closed by pre-tightened bolts (with designed pre-tension value) prior to injection of a suitable cementitious material into the annular space between clamp & existing tubular. Xylan/Teflon/PTFE coated bolts, nuts & washers shall be used.
Contractor shall submit under water repair methodology other than grouting of clamps for approval of company.
- d) Contractor shall carry out under water pre-engineering survey with his equipment & Tools, marine spread, skilled & unskilled manpower, Diving Spread & divers, surveyors, etc. to obtain the as-built details of member(s) & Joint(s) proposed for repair. As-built data provided in the bid, shall be updated, wherever required, to enable the successful execution of the job. Contractor need to collect all necessary field data for design, fabrication & installation of the proposed strengthening.
- e) Submission of marked up drawings / reports based on data of pre-engineering survey shall be submitted to the Company for review/approval.
- f) Detail Design of member(s) & Joint(s) proposed for repair shall be carried out as per standards/codes specified under clause 2.0.
- g) Grouted clamp design and execution / Installation procedure to be submitted by the Contractor and shall be approved by Company.
- h) All necessary engineering, design Basis /criteria and specifications shall be prepared by contractor and shall be submitted for approval of Company. AFC drawings and relevant analysis/ design calculations, specifications shall be submitted to the Company for their review and approval.
- i) Company's comments on Design Calculation & Analysis Reports & Drawings shall be incorporated and revised documents shall be submitted for Company approval.



- j) Contractor shall finalise requirement of sacrificial anodes based on additional steel area due to addition of grouted clamp. Engineering, procurement, fabrication & installation of anodes are in contractor's scope. Anode connectivity to the Jacket shall be provided.
- k) Based on AFC (drawings approved for Construction), contractor shall prepare fabrication/shop drawings and shall procure all the materials required for fabrication.
- l) Pre-Construction survey and submission of the survey report to Company for review.
- m) Members & Joints under repair shall be cleaned by removing marine growth, removal of anodes and other non-structural items obstructions prior to taking up for repair.
- n) Fabrication of grouted clamps, adding fixtures for grouting and all other Installation aid including mobilization of all necessary grouting equipment, Diving Spread on suitable marine spread & material required for the same for successful completion of the job is in contractor scope with demobilization.
- o) Repair of Member(s) & Joint(s) repair is in contractor's scope. Contractor shall take utmost precaution not to damage any existing structure / facilities during execution. In case of any damage, contractor shall rectify the same to the satisfaction of the company without any time & cost.
- p) Contractor and his representative, workers shall follow ONGC safety norms and requirements as per the instruction of company representative to execute the job safely and without any operational hazards. The contractor shall provide personnel protection equipment necessary for the safety of workers and supervisory personnel necessary for the safe execution of work at platform site.
- q) Contractor shall obtain work permits from Company prior to taking up of any hot work and other works to be carried out on the platform as per the rules and requirement of the Company.
- r) Any other activity, not mentioned above, if required for successful completion of the job shall be carried out by the Contractor without any cost and time implication to company.
- s) All existing facilities shall be restored back to their original state & cleaning of work area from all debris, tools & tackles, temporary supports etc. after completion of work.
- t) Removal & relocation of anodes. Removal & disposal of Riser / I / J-Tube clamps if any.
- u) Post Installation/ repair removing of all temporary work shall be carried out with cleaning the Jacket surrounding area. As-built video survey for the executed work (including cleaning & removal of temporary items) shall be carried out and submitted to Company for their review/record. These video surveys, design documents, reports etc. shall be submitted as As-Built Record through OPMAC.
- v) SACS, SESAM, FEM Analysis Software and other proven software (used for analysis) shall be provided to ONGC Engineer at design Centre & ONGC Office for review. All analysis Report with software input file shall be submitted for review.
- w) Scope of works for repairing and strengthening of Jacket members and joints are detailed elsewhere in Bid document.
- x) Repair by infill grout (inside of Member) can be acceptable only when the members are in compression. Members in tension with low UC Ratio value (UC ratio up to 0.4) can be acceptable for repair by grout filling.

2.0 Codes & Standards :

Ref.	Document	Revision	Title
1	API RP 2A- WSD	21 ST Edition	Recommended Practice for Planning, Designing and Construction of fixed Offshore Platforms – WSD, 21 st Edition with Erratas and Supplements 3:October 2007.
2	AISC- ASD	13 th Edition	American Institute of Steel Construction, Specification for Structural Steel Buildings, Allowable Stress



			Design and Plastic Design
3	API RP 2A- LRFD	1 st Edition	Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Load Resistance and Factor Design, 1 st Edition.
4	AISC 360-10	June 22,2010	Specification for Structural Steel Buildings
5	AISC, RCSC	June 30, 2004	Specification for Structural Joints using ASTM A325 or A490 Bolts
6	NORSOK Standard N-004	Rev.2	Design of Steel Structures
7	DNV-RP-C203	October 2011	Fatigue Strength Analysis of Offshore Steel Structures
8	BS EN 1992-1-1 :2004	2004	Eurocode 2: Design of Concrete Structures, Part 1-1, General rules and rules for buildings
9	ASTM A193/A193M	Rev. 01b	Standard Specification for Alloy- Steel and Stainless Steel Bolting Materials for High-Temperature Service
10	HSE OTR 2001/16	-----	Pile/sleeve connections

All other relevant and related Codes concerning the specific job under consideration and/or referred in the above-mentioned Codes shall be followed wherever applicable. Any conflict between the applicable codes and the Design criteria shall be referred to the Company for resolution. Company's decision in this regard shall be final and binding on the Contractor.

3.0 STRUCTURAL ANALYSIS FOR UNDER WATER JACKET REPAIR FOR MEMBER(S) & JOINT(S):

Contractor shall carryout In-place Analysis (Working Stress design method) & Pushover Analysis before repair (for as supplied SACS /SESAM Model) and after repair.

On obtaining Member(s) & Joint(s) Design forces, clamp length design calculation shall be carried out using HSE OTR 2001/016 pile-sleeve connection / NORSOK 004/ DNV rules for classifications of fixed offshore installation to meet its intended purposes and shall satisfy minimum requirement of API RP 2A Chapter 17. FEM Analysis shall be carried out to workout Bolt design forces, clamp shell & flange stress and Stress Concentration Factor (SCF).

3.1 INPLACE, & PUSHOVER ANALYSIS TO WORK OUT DESIGN FORCES:

Contractor shall update the SACS /SESAM Model (global inplace analysis) with Modified stiffness (Modulus of Elasticity and Moment of Inertia) with revised / modified Cd & Cm override for clamp / repair / strengthened member(s) & Joint(s) and obtain forces, deflections for the members & Joints proposed for repair.

Structural Model:

Three dimensional SACS In-place model provided by ONGC shall be modified as per as built details collected during under water pre engineering survey in each of the Structural Analyses.

For infill grouted member, section thickness, elastic modulus and density shall be modelled with equivalent section properties of steel- grout composite. For Grouted clamp, it shall be modelled as concentric tubular in Global SACS analysis.



Foundation Model:

The through leg and Piles shall be represented as concentric tubular members with grouted annulus, with appropriate modelling of the load transfer between the leg and pile.

The foundation model below mudline shall be represented by data describing the non-linear relationship between the soil and the pile. It shall take the form of P-Y (lateral stiffness), Q-Z (bearing) and T-Z (axial stiffness) curves as per the PSI Input file.

3.1.1 IN-PLACE ANALYSIS

Detailed analysis using SACS software shall be carried out by the contractor considering 100% environmental loading along with operating loads to ascertain design forces for damaged members and joints. Updated In-place SACS Model, to ascertain the actual design forces in the members / joints due to proposed strengthening / stiffening. Based on these design forces clamp shall be designed with required Factor of Safety. Contractor shall update the SACS model (global in-place analysis) with Modified stiffness (Modulus of Elasticity and Moment of Inertia) with revised / modified Cd & Cm override for clamp / repair / strengthened member(s) & Joint(s) and obtain forces, deflections for the members & Joints proposed for repair.

Members and Joints check:

Member strength shall be checked at the ends of members and throughout their span in accordance with API RP-2A WSD recommendations and AISC Specifications. Repaired member stress shall be shown through Finite element analysis (FEA). In addition, infill grout members shall be code checked against NORSOK N-004.

Tubular Joint check shall be in accordance with API RP-2A WSD. Joint stress at repaired member shall be shown through FEA. Strengthened joints shall be checked to ensure that it is within elastic limit.

3.1.2 PUSHOVER ANALYSIS:

The objective of the Non-linear Pushover analysis is to check the adequacy of the Jacket against maximum environmental load level that can be sustained by the “intact” substructure and foundation before Global Collapse, and ultimately determine the “intact” reserve stress ratio (RSR) of the Platform. Further Pushover Analysis for all required directions shall be carried out before repair of Structure and reported. Post Repair Pushover Analysis for all required directions shall be carried out with reporting of RSR Value. For the reliability study RSR is defined as the base shear at which the Substructure’s structural system is deemed to collapse divided by the base shear calculated by the reference load. The reference load is taken as 100 year storm loading. The minimum Reserve Strength Ratio (RSR) of the Platform in all eight (8) wave directions shall be reported.

Repaired member(s) & Joint(s) UC ratio should be kept less than one such that the repaired member(s) & Joint(s) does not get failed to achieve RSR of 1.60 at any direction. In case RSR Value of 1.6 is not achieved than Structure shall be investigated to achieve RSR Value of 1.6 for all required directions and shall identify requirement of strengthening of other Member(s), joint(s) & Pile(s) and reported.

Maximum Design force for Member(s) & Joint(s) shall be obtained from Pushover Analysis (to achieve RSR value of 1.6), Inplace Analysis before repair and Inplace analysis after repair. Post repair of Member(s) & Joint(s) UC Ratio shall comply with the above provision.



3.2 FATIGUE ANALYSIS

Fatigue Analysis shall be carried out before repair and after repair using the SACS / SESAM Model and as per Structural Design Criteria Part – I & II.

Stress Concentration Factor for the repair Joint shall be compared before & after repair.

3.3 LOCAL DESIGN:

Finite element analysis (FEA) shall be carried out for the local design of joint(s), member(s) & Bolts (for clamp) where repair work to be carried out based on forces obtained from Inplace Analysis. Repaired member(s) & Joint(s) UC Ratio shall be brought down such level that the Member(s) & Joint(s) does not get fail to achieve RSR of 1.60.

SCF (Stress concentration factor) Values for the repaired Joints / Clamps / Clamp Flanges, etc. shall be obtained using Finite Element Analysis with simulation.

Coefficient of Friction between Concrete & Steel shall be considered as 0.40 for all design calculation & FEA Analysis.

3.4 CLAMP BOLT, FLANGE, AND STIFFENER DESIGN:

Bolt force shall be obtained using FEA Analysis. Bolt forces shall be added with 10% bolt relaxation value for bolt tightening in one go of installation. Bolt UC ratio (total) shall be kept below 0.7 to sustain the cyclic loading (under this Bolt UC Ratio, bolt fatigue analysis is not included in the scope) from wave forces. Clamp flange plate shall be designed for full capacity of Bolt Forces (irrespective of actual bolt force). Welding between Flange Plate to Clamp shell shall be full penetration weld from both sides. Welding between Stiffeners to Flange plate shall be full penetration weld. Welding between Stiffeners to clamp shell shall be fillet weld.

4.0 REPAIR METHOD:

Repair methodology by using doubler plates/mechanical clamps/grouted clamp having multiple segments, which are placed around an existing damaged tubular/joint and grouting of damaged structural members shall be as follows.

4.1 DOUBLER PLATES

The doubler plates / sleeves shall be designed as per latest edition of API-RP-2A. Modified stiffness shall be considered in the global analysis.

4.2 MECHANICAL CLAMPS

The mechanical clamps shall be designed in accordance with API-RP-2A. All bolts / stiffeners of clamp connections shall be designed in accordance with AISC 13th edition. All clamps, nuts & bolts shall be fluoro-polymer coated (xylan type).

4.3 GROUTED CLAMP DESIGN

The grouted clamp shall be designed with high strength grout properties of minimum 28 day characteristic strength of 16000 psi (110Mpa) and appropriate radial stiffness factor. The grout annulus is to be of width minimum 38 mm. The interface bond strength shall be as per formula given below. Grout material shall possess properties such as rapid strength development & high elastic modulus. Grout shall have non shrinkage, high sulphate resistance (HSR) properties and no shrinkage in sealed condition. At least 40% of the design compressive strength and 75% of elastic modulus of the grout should be achieved within 24 hours, this should also provide better fatigue strength compared to conventional grout. However Bond strength shall be calculated without considering the shear keys/weld beads.



5.0 STRENGTH FORMULATION FOR GROUTED CONNECTION (HSE PILE/SLEEVE CONNECTIONS)

The characteristic bond strength of a grouted connection, with or without mechanical shear connectors satisfying the requirements of Section 2.2, HSE Offshore Technology Report 2001/016 on Pile/Sleeve Connection, is given by:

$$f_{buc} = K \cdot CL(9C_s + 1100 h/s) (f_{cu})^{1/2}$$

Where,

- f_{buc} = is the characteristic bond strength of grout (in N/mm²)
 f_{cu} = is the characteristic grout compressive strength (in N/mm²)
 K = is the stiffness factor defined below
 CL = is the coefficient for grouted length to member diameter ratio
 C_s = is the surface condition factor
 h = is the minimum shear connector outstand (in mm)
 s = is the nominal shear connector spacing (in mm)

$$K = [m (D/t)g]^{-1} + [(D/t)p + (D/t)s]^{-1}$$

Where,

- m = is the modular ratio of steel to grout
 D = is the outside diameter
 t = is the wall thickness and subscripts g , p and s relate to grout, member and sleeve respectively.

In the absence of other data the modular ratio m may conservatively be taken as 18 for the long term (i.e. 28 days or more).

The available data on the parameter CL are limited. In the absence of data relating to a specific tubular and shear connector geometry, the following values of CL should be assumed:

L/D_p	CL
2	1
4	0.90
8	0.80
≥ 12	0.70

Where,

- L = is the nominal grouted connection length.

Intermediate values for $L/D_p < 12$ should be calculated by linear interpolation.

The surface condition factor C_s should be taken according to the following:

- If shear connectors are present and satisfy the requirement $h/s \geq 0.005$ then C_s may be taken as 1.0.
- For plain pipe connections and for connections with shear connectors but with $h/s < 0.005$, then, in the absence of test data, C_s should be taken as 0.6.

The values in i) and ii) above refer to shot-blasted or lightly rusted surface conditions. Other conditions (e.g. painted surfaces) should receive special consideration.

6.0 SAFETY FACTORS



In determining the permissible working bond stresses from the characteristic bond strength calculated using the above formulation, the following safety factors given below should be applied.

Loading Condition	Safety Factor
Extreme	4.5
Operating	6.0

7.0 MATERIAL FOR GROUTING

7.1 GROUT (CEMENTITIOUS) MATERIAL

Ultra High Performance Cementitious (UHPC) material of proven track record as per API 10A shall be selected to achieve minimum 28 day compressive grout strength of 16000 psi.

Simulation Test (after production of material and before actual use) shall be carried out for the proposed UHPC Material (for actual use for the project) like Water Cement Ratio, Grout fluidity, duration of Grout fluidity, initial setting time, final setting time, Cube Crushing Strength, Grout Density, Bond Strength between Grout & Steel, Coefficient of Friction of Concrete & Steel, Modulus of Elasticity of Grout. Simulation Test shall be physically witnessed by Company Certifying Agency and or Company appointed inspector and record their views / acceptance.

7.2 GENERAL REQUIREMENTS OF CEMENTITIOUS MATERIAL

Contractor shall mobilize extra quantities of Cementitious material for smooth Installation. The specimens taken from the field should be subjected, until test, to a curing regime representative of the situ curing conditions, i.e., underwater and with appropriate seawater salinity and temperature. (As per #8.4.1 of API RP2A).

7.2.1 EX-STOCK CEMENTITIOUS MATERIAL

Cement supplied ex-stock shall not be accepted without proper identification and without manufacturer's certificates with identification on bag/container as required in 8.2.2 hereinafter. Cement manufactured over six months prior to actual use shall not be used for construction

7.2.2 MANUFACTURER'S CERTIFICATE OF CEMENTITIOUS MATERIAL

- The Contractor shall submit Original manufacturers' test certificates to the Company for physical variation for all cements the contractor intends to use for the works whether procured freshly or being supplied ex-stock. The certificate shall indicate the manufacturer's name, trade mark or other means of identification, the batch number and date of manufacture and test results covering fineness, chemical composition, compressive strength at 1 day, 3 days and 28 days, initial and final setting time, shrinkage/expansion and soundness. All tests shall be carried out as specified below. Company appointed Inspector shall physically verify the Cementitious Material with respect to Original Mill test Certificate and accept same before use. Any Cementitious material rejected shall be disposed-off without cost & time implication to the Company.
- All tests for the cement shall be carried out as specified in ASTM C- 109 and or other relevant ASTM Codes.
- Shrinkage/expansion test shall be carried out as specified in ASTM designation C-806-87 "Restrained Expansive Cement Mortar" or by similar acceptable method.
- Identification of the cement intended to be used for the works shall be co-relatable with the identification on the manufacturer's test certificate.



- v) Cement Grout Mix Design shall be carried out for the supplied Cement batch, which shall comply with the Parameters considered for Design calculation. This Mix design shall be witnessed by the Certifying Agency. The mix design report shall be made available at site so the mixing parameter (Water Cement Ratio, type of water, other components) can be witnessed by Inspecting Authority & Certifying Agent at Site of Works.

7.2.3 TESTING REQUIREMENTS OF CEMENTITIOUS MATERIAL FOR GROUTING:

On site sampling shall be performed and test cubes will be cast for 28 day strength verification. The cubes will be tested in an independent accredited onshore testing laboratory.

Test cubes (cube of 75 mm side) shall be cast at various stages during the grouting operations and will include samples taken from the start, middle and end of grouting of each clamp. The sample will be taken from the mixer during the operation. A minimum number of 3 (three) cubes will be cast at each stage. Test cubes will be de-moulded after 24 hours, stored and cured in water bath prior to testing. If the test results do not satisfy the minimum compressive strength requirements, LSTK Contractor shall be responsible for making suitable rectification measures to ensure adequacy of the strengthening arrangement.

8.0 BOLT MATERIAL:

All bolts, nuts & washers for use in the submerged and splash zones shall be flouro-polymer coated (XYLAN type) or equivalent. Coating color for all bolts and nuts shall be "Red". All bolts & nuts shall be of ASTM A-193 Grade B7 and nuts of ASTM A-194, grade 2H and shall be designed as per AISC.

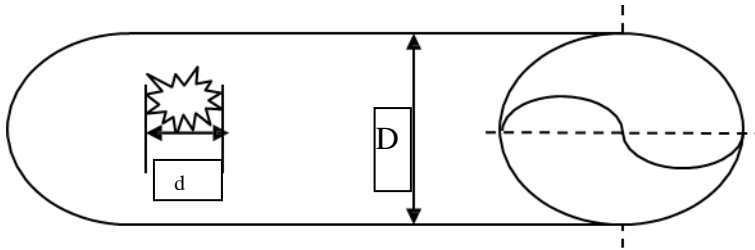
All bolts, nuts and washers fixed to external surfaces and internal surfaces exposed to natural ventilation shall be of stainless steel ASTM A-193 Grade B8M and nuts of ASTM A-194, grade 8M.

Sr. no.	Properties	Requirement
i	Corrosion resistance	salt spray test up to 3000 hours (nuts not frozen) (ASTM B117)
ii	Adhesion	5B (ASTM D3359)
iii	Pencil Hardness	5H-6H (ASTM D3363)
iv	Kinetic friction coefficient	0.06-0.08
v	Elongation	35%-50%
vi	Tensile strength	27.6 Mpa (4000 psi)
vii	Operating pressure	upto 690Mpa (100,000 psi)
viii	Coating Thickness	25 µm to 40µm
ix	Impact	18.43 Nm (160 in.lb) (ASTM D2794)
x	Thread fit	Over tapping of nuts 0.25mm (0.010'')
xi	Dielectric strength	500 volts per 25 µm
xii	Operating temperature	-100°C to +260°C

PTFE coating on fasteners will have a uniform thickness of 20 ± 5 microns to 45 ± 5 microns thick.

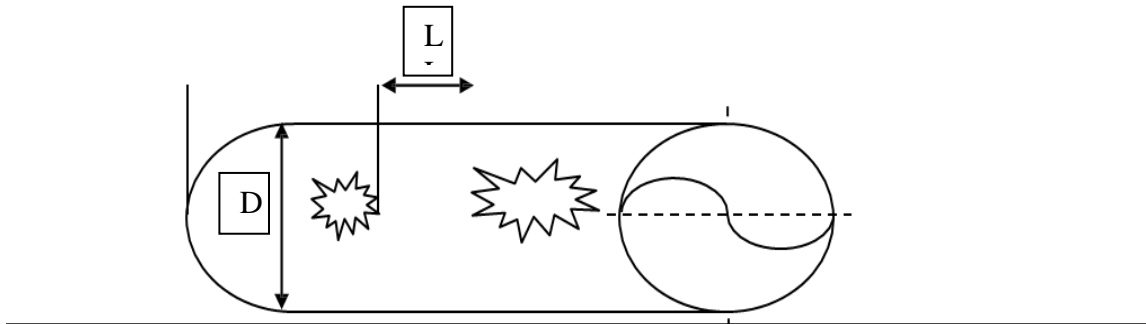
9.0 GUIDELINES FOR REPAIR OF JACKET WALKWAY MEMBERS:

Contractor shall follow while carrying out repair work pertaining to jacket walkway members having holes on them.



If $d > D/5$ then the complete segment of the member needs to be replaced. However, if $d < D/5$, then the member can be strengthened using doubler plates.

Where d is the largest dimension of observed hole on the member.



If $L < 914\text{mm}$ or D (whichever is less), the complete segment containing the two holes as a combination needs to be replaced. If however, $L > 914\text{ mm}$ or D (whichever is more), the member can be strengthened using separate doubler plates subject to meeting requirements of 1) above.

Where L is the Clear Spacing between two holes on a particular member

3) All strengthening work shall be in accordance with API RP 2A and API spec 2B. Final joint configuration and arrangement shall also meet requirements of API RP 2A.

Note: For both clauses 1) and 2) above, the segment is defined as a length on either side of the hole until original thickness of member is achieved. The LSTK Contractor shall carry out UT survey for checking the thicknesses of the members. In case the above necessitates complete dismantling and replacement of entire member, the same is also in scope of the LSTK Contract.

10.0 INSTALLATION/REPAIR PROCEDURE:

LSTK Contractor shall furnish the detailed installation procedure for the repair method adopted for approval by Company 60 days prior to installation incorporation all design aspects. Design consultant shall review & certify the Installation Procedure regarding incorporation of all Design Parameters. Vetting of MWS shall be obtained and submitted.



11.0 AS-BUILT DOCUMENTATION:

Installation process shall be video recorded and after installation As-Built Video survey shall be carried out. All videos shall be submitted under As-built Documentation.

Post Installation, As-Built Drawings shall be prepared by Design Consultant and shall be approved by ONGC. As-Built Drawings, Analysis Reports and Input files of respective Analysis in respective software format shall be submitted under As-Built Documentation.

Documents for fabrication shall contain Material Inspection Report with MTC, Material traceability with inspection report, Dimension control Report, Welding Inspection Reports, UT & RT Records, Loadout Report, etc. and shall be document progressively during Fabrication & Installation.

- **END** -



**Offshore Engineering
Services
ISO - 9001:2015**

**ELECTRICAL DESIGN
CRITERIA**


**PROCESS
PLATFORM**

Spec. No.	3.5.1
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ELECTRICAL DESIGN CRITERIA FOR PROCESS PLATFORM

Prepared / Revised By	Reviewed By	Approved By	Total No. of Pages	Date	Rev. No.
AM	AK	PK	23	06.12.2021	10
A.M.	N.N.J.	N.N.J.	22	06.05.2019	09

FORMAT No. OES/SOF/028	Ref. PROCEDURE No.	ISSUE No. 03	REV. No. 00	REV. DATE: 26.02.2018
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	Offshore Engineering Services ISO - 9001:2015	ELECTRICAL DESIGN CRITERIA	Spec. No.	3.5.1
			Rev. No.	10
		PROCESS PLATFORM	Discipline	Electrical
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3.5.1 ELECTRICAL DESIGN CRITERIA FOR PROCESS PLATFORMS

The Electrical Design Criteria broadly outlines the design philosophy, methodology and Documentation requirement for a process platform. Project specific requirement of the electrical system is provided in basic bid work enclosed with the Bid.

3.5.1.1 DESIGN PHILOSOPHY:

3.5.1.1.1 The electrical system on an offshore platform is designed to provide

- Safety to personnel and equipment
- Reliability of service
- Minimal fire risk
- Operational flexibility
- Optimization of available space
- Ease of maintenance and convenience of operation
- Automatic protection of all electrical equipment through selective relaying system
- Adequate provisions for future expansion and modification
- Maximum interchangeability of equipment
- provisions of integration with existing facilities, wherever required

3.5.1.1.2 Electrical Equipment / Material Selection


All electrical equipment / material (viz. motors, transformers, switch gears, distribution system, cables etc.) offered by the vendor are to be as per relevant standards, specifications, new and unused, of current manufacture and the highest grade and quality available for the required service, and free of defects. The Electrical equipment and material shall be designed for reliable & trouble free performance for the design life of the platform. Should any equipment or material prove unsatisfactory it is to be rejected notwithstanding any acceptance in previous projects.

The selection of electrical equipment / material is generally based on the following:

- Electrical Design Criteria and Functional specifications in respect of each individual equipment
- Applicable Standards, Codes & Recommended Practice
- Operating site conditions
- Hazardous area classification

3.5.1.1.2.1 Codes and Standards:

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The latest version of the International Codes, Standards, Regulations and recommended practice being followed by the Industries world-wide are to be followed. The requirement of these standards, codes etc. are to be considered as supplementary to the requirement of Design Criteria and Functional specifications. Compliance to P & NG Rule 2008 is a statutory requirement. Some of the applicable standards are listed below

IEC	-	International Electro technical Commission
BIS	-	Bureau of Indian Standards
NEMA	-	National Electrical Manufactures Association (USA)
ASTM	-	American Society for Testing of Material (USA)
NFPA	-	National Fire Protection Agency (USA)
IALA	-	International Association of Marine Aids to Navigation and Lighthouse Authorities
BSI	-	British Standard Institute
ANSI	-	American National Standards Institute
API	-	American Petroleum Institute (USA)
NEC	-	National Electric Code (USA)
SOLAS	-	Safety of Life at Sea
NESC	-	National Electric Safety Code
DNV	-	Det Norske Veritas
NACE	-	National Association of Corrosion Engineers
ATEX	-	Atmospheres Explosibles


3.5.1.1.2.2 Site Conditions

All electrical equipment and accessories / material shall be suitable for installation and operation under extremely saline, humid, corrosive and hostile marine environment with specified degree of hazards including H₂S (wherever required). In general, all outdoor electrical equipment shall be designed for 40°C temperature and maximum 90% relative humidity while the indoor equipment shall be designed for 45°C temperature and maximum relative humidity of 90%.

3.5.1.1.2.3 Degree of Protection

The enclosures for outdoor equipment are to be classified to IP-56 as a minimum degree of protection, increased as necessary where the location/situation demands however Electrical Motors with IP-55 will be acceptable subject to provision of canopy where ever required. Indoor equipment, where ever not specified in their respective Functional specifications, will have a minimum of IP 41 protection and accessible equipment within enclosures will be a minimum of IP-20 degree of protection. Where indoor has specific ventilation requirement lower ingress protection rating may be considered subject to evaluation.

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3.5.1.1.2.4 Hazardous Area Classification & Electrical Equipment Selection

- 1) The hazardous area classification shall be carried out in accordance with API RP-500 or API RP-505. Contractor to follow any one standard throughout the project.
- 2) Hazardous area classification drawings of the Platform shall be prepared by the contractor. Approved area classification drawings shall form the basis for layout and selection of electrical equipment.
- 3) Selection of Electrical Equipment shall be done
 - i. As per Section -4 of API RP 14 F if area classification is done as per API-RP-500
 - ii. As per API RP 14FZ / IEC-60079-14 if area classification is done as per API-RP-505
 - iii. Use of Ex (e) in Class 1 Division 1 or Zone-1 areas shall be as per latest edition of IS 5571
- 4) All the equipment selected for use in Hazardous area shall have surface temperature limited to 200°C (T3).
- 5) All equipment meant to be used in hazardous area shall be certified by BASEEFA, UL, FM, CMRI or an Internationally Recognized Certification Agency for the area and service in which they could be used.

3.5.1.1.3 POWER SYSTEM

Overall power distribution of the platform shall generally be as per the indicative power distribution scheme enclosed with the basic bid work (Electrical).

3.5.1.1.3.1 Main Power

Main power requirement for the platform shall be sourced from one of the following.

1. Main generators installed on the new platform.
2. Additional power, if available, from the existing bridge connected platform.

The main generators shall be gas turbine driven generators or Dual Fuel Powered with Generation voltage of 6.6 kV or 11 kV.

Basic Bid Work (Electrical) enclosed in the Bid Package shall be referred for project specific requirement.

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3.5.1.1.3.2 Emergency Power

Emergency power requirement for the platform shall be sourced from one of the following.

1. Emergency generator installed on the new platform
2. Additional emergency power, if available, from the existing platform bridge connected to the new platform.

The emergency generator shall be Diesel Driven Generator and shall be capable of supplying the emergency loads of the platform connected to the emergency switchboard. Emergency power generation is generally at 415 V. Facility for momentarily paralleling of EDG with normal power to facilitate restoration of main power after black-out, shall be provided. Facility for auto-start of EDG in case of blackout shall be provided.

Basic Bid Work (Electrical) enclosed in the Bid Package shall be referred for project specific requirement.

3.5.1.1.3.3 Critical Power

Critical supply for the platform shall be met by DC Systems and AC UPS system.

3.5.1.1.3.4 Generation and Utilization Voltage Levels


Voltage Level Classification

1. Low Voltage (LV) - Up to 1000 Volts.
2. High Voltage (HV) – Above 1 KV and up to 35 KV.

Utilization Voltage Levels

1	6.6 / 11 KV AC, 3 Ø, 50 Hz	For Main Generators and motors rated above 160 kW.
2	415 V/230 V AC, 3 Ø, 50 Hz (Phase to phase / Phase to neutral)	For Emergency Generators and motors rated between 0.37 KW and 160 kW, Battery chargers, UPS, HVAC, Bulk AC loads (like Process heaters), etc.
3	230 V AC, 1 Ø, 50 Hz (Phase to neutral)	For motors rated below 0.37 KW, Platform communication system, Anti- condensation space heaters, Convenience outlets
4	230 V AC, 50 Hz (Line to Line)	Level gauge illumination, Platform Illumination system (Normal Lighting), etc.
5	110 V DC, 2 wire	Critical lighting, Switchgear &

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		Generator Controls, DC motors for Emergency lube oil pumps, etc.
6	24 V DC, 2 wire	Instrument supply, Fire & Gas detection system, CP monitoring panel etc.
7	24/12 V DC, 2 wire	Navigational Aids system
8	110/230 V AC , UPS	Distributed Control System
9	230 V AC, UPS	Telephone Exchange, CCTV system, Radio system, Paging & Intercom system, Telemetry, telecom and computer system

3.5.1.1.3.5 Power system Earthing

Power System earthing shall be as given below.

- LV (AC) – Neutral solidly grounded.
- HV (AC) – Neutral grounded through low resistance.

3.5.1.1.4 Allowances for future / sparing

A sparing allowance of 20% shall be provided for switchboards, terminals, MCTs, distribution boards and DC supply & UPS system including battery systems.

3.5.1.2 DESIGN METHODOLOGY


Electrical Equipment Sizing Methodology

3.5.1.2.1 Electrical Loads - Definitions

The following definitions are applicable for assessment of load.

Brake Power (KW) –	Power transmitted along the shaft to the mechanical equipment
Nominal power –	Name plate rating of motors or load absorbed by non-motor load.
Efficiency (%) –	As per vendor data the ratio of output power to input power complying with IEC Standard 60034-30.

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Operating load -- Brake Power of Rotating equipment and Power transmitted to static loads under fully loaded conditions

3.5.1.2.2 Load Classifications

Electrical loads are classified into Normal, Emergency and Critical. Each category comprises of the following loads.

Normal	1	Process loads
	2	Utility loads
Emergency	1	Essential process and utility loads which are required for pre-commissioning and safe shutdown / start up.
	2	Entire living quarters and associated systems
	3	Building HVAC system
	4	Entire lighting system
	5	Entire plant and personnel safety system
	6	All material handling equipment
	7	All life support systems for normal operation of LQ and safe abandonment of the platform in case of emergency
	8	Utilities of one GTG of the platform
Critical	1	Entire DC Loads
	2	UPS Loads

3.5.1.2.3 Utilization Category

Loads will be divided into following three classes according to use.

- Continuous - Loads which draw power at continuous rate
- Intermittent - Loads which draw power for a fraction of time given by the duty cycle of the load
- Stand-by - Loads which are connected with power supply and ready to act as and when required.

3.5.1.2.4 Load Assessment

An Electrical load list shall be developed by contractor based on estimated operating load as identified in equipment list plus losses.

This data shall be used to specify generating capacity for main power, Transformer & emergency power and switchgear configuration to provide continuous support of running loads and starting the largest drive with the remainder of the active connected load in service.

In evaluating load summary, utilization category is applied as follows;

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A.Main Generators

- | | |
|-----------------------------------|---|
| (a) Continuous Load | - 100% of continuous load |
| (b) Intermittent load | - 50% of the total intermittent load or the largest intermittent load, whichever is greater |
| (c) Stand-by equipment | - 10% of total 'standby' load or largest stand-by load, whichever is greater |
| (d) Margin for future load growth | - 10% of sum of (a), (b) & (c) above |

The total load shall be sum of (a), (b), (c) and (d).

The stand by philosophy of Generators is specified at Basic Bid work.

B. Transformer

The methodology for calculation of total load for Transformer sizing shall be the same as that of Main generators.

The transformers shall be sized, using the natural air-cooled rating. More than one identical Transformer can be selected for large systems, where single Transformer cannot feed the total platform load due to limitations of load and fault currents of switch gear. In all cases one additional Transformer of identical rating shall be provided as standby for redundancy. The Bus shall be sectionalized with Bus coupler with equal distribution of electrical loads such that each Transformer including the stand by shall feed a dedicated Bus section. Each Transformer shall be sized to meet the load requirement of two Bus sections.

C.Emergency Generator

- | | |
|-----------------------|---|
| (a) Continuous load | - 100% of continuous load |
| (b) Intermittent load | - 50% of the total intermittent load or the largest intermittent load, whichever is greater |

The total load shall be sum of (a) and (b).

3.5.1.2.5 Fault levels

As part of detailed engineering, initial fault current calculation shall be carried out based on typical vendor data for machine parameters, taking account of design tolerances. The calculations should identify the maximum expected values of switch gear making and breaking fault currents, including motor contribution. Calculations are to be done as per IEC 60909. Bus bar and Switchgears are to be designed for fault duration of 1 second with a margin of

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20% over calculated fault level. Final calculations shall incorporate actual equipment data.

3.5.1.2.6 Cable

The voltage rating of cables shall be as per the standard international practice for the utilization voltages defined. Cables for safety systems like critical lighting system, navigational aids, F&G system and Communication system etc. shall be fire resistant. All other cables shall be FRLS type. Cable joints via cast resin kit or other type are not permitted on the offshore installations.

All power cables shall be sized considering an ambient temperature of 40 C and de-rated for grouping and method of installation. The sizing calculations shall take into account the following–

- Connected load with design margin of 10%.
- Current carrying capacity
- Voltage drop
- Short circuit temperature rise
- Laying conditions - de-rating factor of 0.7 for grouping


3.5.1.2.7 Voltage Drop

A. The maximum allowable voltage drop in any feeder under steady state condition is to be maintained as follows –

Motors	3%
Switch Boards / Distribution Boards, Lighting / Power Panels	1%
Lighting Points	2%
DC System	2.5%

B. The voltage drop at the worst affected pre-loaded bus shall not exceed 15% of nominal voltage during start –up of the largest motor or any group of motors that will be started simultaneously.

C. The voltage available at motor terminals during start- up shall be sufficient to ensure positive starting and acceleration to full speed by the motor (even in fully loaded condition of motor, if required) without causing any damage to the motor. However, under no circumstances, the voltage at motor terminals during starting is allowed to fall below 80% of the nominal voltage for DOL starting.

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3.5.1.2.8 Plant Earthing

- Plant earthing shall be as per API- RP-14F. Double earthing (two independent earth connections to earth grid) for all electrical equipment shall be provided. Double earth bonding shall be required for all metal equipments and structures. However the lighting fixtures can be wired with 3 core cables (2 phases and earth). Where cables are not used, separate earthing wire of same size as phase and neutral shall be run for earthing the lighting fixtures.
- The minimum size of earth bonding conductors on local control station enclosures shall be 6mm². The minimum size of earth conductors for electrical panels shall be 16 mm².
- Vessels, tanks, and mechanical packages not directly welded to the structure shall be bonded to a structural earth pad or boss using at least two independent 70 mm² conductors.
- Items such as pipes and duct work that have insulating material (i. e. gasket) between connected sections shall be made electrically continuous by bonding with a 6 mm² earthing cable or equivalent earthing strip.
- All electrical panels shall be provided with a tinned copper earth bar.

3.5.1.2.9 Plant Layout

The Contractor shall install electrical equipment with due consideration of the following:

- Positioning of equipment (outdoor and indoor) shall not constitute a safety hazard.
- Visibility and accessibility for both maintenance and operations purpose.
- Light fixtures shall be fitted so that they can be serviced and removed by a single person.
- Overhead Cable tray height must be minimum 2.5 meters for safety and convenience.
- Transformers shall be located in naturally ventilated sheltered, unclassified space fully protected from rain and storm water. It shall be located adjacent to switchgear room.

Electric room (Switch gear room) shall be located in safe, non-hazardous area. All electrical equipment in the switchgear room shall be designed considering inadequate ventilation in the room. All cables inside the switchgear room shall

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be laid under false flooring. False roofing is also to be provided for switchgear rooms. Insulating mats, as per the voltage levels, shall be provided at front and back of all electrical panels.

All batteries shall be located in closed battery room .The room will be located in safe area. Batteries shall be designed considering inadequate ventilation in the room.

For convenience and ease in maintenance as well as operation, the minimum clearance between electrical equipments or between other items and electrical equipment shall be as tabulated below:

Sl No	Description	Clearance
A	Floor Mounted Equipment	
1	Front clearance for HV. Switchboards	2000 mm
2	Front clearance for all other switchboards/ panels	1500 mm
3	Rear clearance for panels having only front access	150 mm
4	Rear clearance for panels	1000 mm
5	Side clearance between two switchboards (but not less twice the width of each panel)	1500 mm
6	Side clearance between switchboard and nearest obstruction	1500 mm
7	All around clearance for transformers	1000 mm
B	Wall mounted equipment	
1	Front clearance	1000 mm
C	Battery Bank	
1	Battery rack to wall clearance for following arrangements	
1.1	Single row, single/double tier	100 mm
1.2	Double row, single tier	100 mm
1.3	Double row, double tier	750 mm
2	Rack to rack front clearance	750 mm
3	Rack to rack side clearance	< 150 mm or > 750 mm
D	General	

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1	Head room clearance for all above equipments excepting transformer	800 mm
2	Head room clearance for transformer in transformer room	2000 mm

The minimum distance between power/control wiring and electronic signal wiring on prolonged cable route will be as follows –

Power / Control cable	Minimum distance from electronic/ signal cable
Up to 300 V	150mm
Up to 1000 V	300mm
Above 1000V	450mm

HV cables shall be installed on dedicated trays/ladders.


Intrinsically safe circuit cables shall be separated from other cables by 50mm spacing or metallic barrier.

3.5.1.2.10 Switchgear

All HV/LV switchboards shall be fed by more than one incomer and shall be sectionalized with the help of bus couplers. The Bus couplers shall have provision for synchronization for Generators and short time paralleling facilities for Transformers to enable feeder changeover without interruption. Dedicated switch board shall be provided for emergency loads with synchronizing facility for Emergency Generator. Facility for momentarily paralleling of EDG with normal power to facilitate restoration of main power after black-out, shall be provided. All Electrical panels shall be Epoxy painted.

LV Feeders rated for more than 400 Amp shall be provided with ACBs. Feeders for more than 63 ampere rating and up to 400 ampere rating shall be provided with MCCBs. Feeders up to 63 ampere rating may be provided with MCBs. However, all motor feeders below 63 amps shall have only MCCBs regardless of ampere rating. Bus bar and isolating devices shall be rated at 120 % of design load. Bus bars are generally identified as R, Y & B with phase coloured as red, yellow and blue. All the switchgears shall be industrial grade equipment installed in freestanding sheet metal cubicles of modular design. Main Circuit Breakers shall be withdrawable air break type with motor charged spring release and close mechanism.

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Electric Motors

3.5.1.2.11 LV Motors

All LV motors shall be totally enclosed fan cooled (TEFC) motors with class F insulation, temperature rise limited to class B.

Any motor rated 75 kW and above, shall be fitted with positive temperature coefficient thermistors. If motors are used with variable speed drives, they shall also be fitted with positive temperature coefficient thermistors. Motors rated 3.7 kW or above are to be fitted with anti- condensation space heaters which will be energized when the motor is not running.

3.5.1.2.12 HV Motors

HV induction Motors for large equipment shall be totally enclosed fan cooled (TEFC) with class F insulation with temperature rise limited to class B and suitable for operation in the hazardous area where it is installed. All HV motors shall be fitted with winding and bearing temperature RTD's, wired back to a separate junction box. Vibration protection shall also be provided. HV motors shall be fitted with space heaters which will be energized when the motor is not in operation.

3.5.1.2.13 Power Management System & HMI

Power management system (PMS) with automatic load shedding panel shall be provided if the main supply generation is by more than one TG. It shall be PLC based control scheme and located in the GTG Control Room.


PMS shall have following functions as a minimum;

- Display of complete power system schematic along with important operational parameters.
- Control (Start / Stop) of Major power system equipment like GTG, EDG Transformers, Tie Breakers, incomers etc.
- All operations related to synchronization.
- Load shedding scheme shall allow continued partial operation of the platform in case of tripping of one or more unit of TGs. The loads shall be divided into various categories priority wise. In the event of tripping of one or more TG sets, non- priority loads shall be disconnected within the stability limit of healthy TG(S).

A HMI/Console shall be provided for monitoring of Switchgear status in Switchgear Room facilitating following as a minimum;

- Monitoring breaker status (such as opened/closed/trip) and relay parameters for all HV panels and main incoming LV breakers.
- Monitoring voltage, current and power for all HV panels and main incoming LV panels and motors of 30 kW and above.

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- Monitoring DC system and AC UPS with following annunciation signals as minimum.
- Charger failure
- UPS failure
- Under voltage
- Over voltage
- Earth fault
- Cooling fan failure
- AC supply failure

It will be possible to program and monitor the PLC/ HMI from a laptop. For this purpose, a laptop shall be provided by the contractor with all the required software preinstalled.

3.5.1.2.14 Lighting

A. All lighting shall be LED type.

B. Lighting levels shall be designed as per API RP 14 F and supplemented by Indian standards and shall include a further 10% design allowance to cover lamp deterioration and dirt accumulation on the fixture lens over a period of time.

C. The lighting system shall be designed in accordance with recommendations of Illumination Engineering Society (IES) and to achieve minimum levels of illumination as per API RP 14F.


D. Luminaries shall be circuited such that illumination in any area shall not be lost if one sub circuit fails.

E. Type of lighting fixtures shall be restricted to minimum and shall preferably be supplied from one vendor.

F. Indoor non- hazardous areas shall be provided with industrial LED luminaries. For control room, switch gear room and office rooms and Living Quarters decorative type Light fittings shall be provided. For indoor areas with false roofing, all light fixtures shall be recessed type.

G. Floodlighting shall-be provided for large and open areas such as main deck, jacket walkways and boat landing etc. Proper access platforms with vertical caged ladders shall be provided for the same. All external light fixtures shall be suitable for the area classified but as a minimum should be for class 1 division 2 for oil and gas platforms. Ingress rating of these fittings shall be minimum IP 56.

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H. Lighting for gauges shall be provided with local On/Off switch.

I. The highest point on the platform shall be fitted with omni-directional red obstruction light.

J. Lighting on the platform is divided into 3 categories, Normal Lighting, Emergency lighting and Critical lighting. Each category is defined in the following sections.

(i) Normal illumination level is the total illumination provided by normal and emergency lighting. Normal lighting on the platform shall provide safety to operating personnel and also ensure effective and efficient job performance. DC lighting shall not be considered for this.

(ii) Emergency lighting fixtures of LED type (indoor and outdoor) with self-contained battery and inverter shall be located near exit points, rotating equipment and Building Module. Outdoor emergency lighting shall have Ingress protection of IP56. All the emergency lighting fixtures will be suitable for Zone 1, Gas Group IIA and IIB, Temp Class T3 (as per IEC 60079-10) or equivalent. Emergency light fittings shall be in accordance with IEC 60598-2-22 and hence shall have battery autonomy of 90 minutes.

(iii) DC critical lighting fixtures (LED) shall be provided in all areas to provide safe access for personnel evacuation points and in the control, generator and other building areas to permit emergency operation for safe shutdown of the platform in the event of mains failure. Illumination by emergency lighting shall not be considered for the calculation of critical lighting levels.

Critical lighting shall provide a minimum horizontal level of illumination as per API RP 14 F (standby lighting). Critical lights shall normally be kept 'ON' and fed through the chargers and be automatically switched over to battery banks in case of AC failure. All critical lighting fixtures shall be suitable for Zone 1, Gas Group IIA and IIB, Temp Class T3 (as per IEC 60079-10) or equivalent. Lighting fixtures provided in each 'EXIT' leading to walkways and life boat stations shall be fitted with green lens.

3.5.1.2.15 Socket outlets

Two types of socket outlets are provided on the platform.

(1) 415 V, 50 Hz, 3 wire plus earth 63 amp, 4 pin for welding sets

(2) 240 V, 50 Hz, 2 wire plus earth, 15 A, 3 pin (IS 1293 / BS 546)

They shall generally be industrial type, metal clad and surface mounted construction. However, the sockets provided in control rooms and building areas shall be decorative type. The outlets for out-door shall be certified for use in Class 1 Division 1 (as per API RP 500) or Zone 1 (as per API RP 505). The number of

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socket outlet for 15 Amp shall be such that at least one outlet is available for every 15 meters distance. 63 Amps welding outlets shall be such that any point on the platform can be reached using a 50 meters cable. Socket outlets shall be provided with earth leakage protection, 30 mA for 240 V, outlets and 300 mA for 415 V, welding outlets via dedicated distribution board.

3.5.1.2.16 Navigational Aids

The navigational aids along with associated DC supply and battery is to be provided on the platform. Battery for Navigational Aids shall have autonomy time of 7 days.

3.5.1.2.17 Cable Transit Systems

Cables shall be routed through FRP, UV protected cable trays. Cables and cable ladder shall not be fixed to gratings or handrails. Cables shall be properly tied in cable trays at 800 mm interval. Associated accessories shall be SS-316.

Suitable size double compression type glands shall be supplied for all cables. For entries into Ex(d) enclosures, barrier type (or compound filled) glands shall be provided. All cable glands are to be type tested and certified for use in specified hazardous area. Cable glands shall be nickel plated brass or equivalent.

All cable penetrations through firewalls, switchgear room walls and between safe and hazardous area shall be sealed using multi cable transits to maintain fire integrity of the system and prevent gas migration. Cable transit frames are to be supplied with test certificates from an accredited independent test authority to confirm a fire and blast rating adequate for the deck or wall in which they are to be installed.


Cable transit frames shall be fitted where cables pass through:

- Decks and walls to open air,
- Fire walls,
- From safe to hazardous area.

3.5.1.2.18 Motor Actuated/Operated Valve's

All actuators driven by motor shall be three phase, squirrel cage induction motor conforming to the ISO 22153 (Electric Actuators for Industrial Valves), IEC 61158-2. The motor shall be provided with Class F insulation, rated for Class B temperature rise. IEC 60034-1 shall be followed for S duty cycle of actuator motor. The actuator motor shall be rated for minimum 'S2-15 minutes' duty. In all cases, the motor shall be suitable for following requirements:

- Minimum 3 nos. of consecutive starts in hot condition.
- Minimum 8 nos. of starts distributed over 15 minutes.
- The motor shall be able to operate the actuator at 80% of rated voltage.

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- The stall torque of motor shall be at least 25% greater than maximum torque required for operation of valve.
- Valve shall be as per FS-2004A, Functional Specification for Piping Design.
- Minimum IP 66 enclosure is required, MOV/MAV shall be as per area classification suitable for area in which it shall be installed.

The following operation shall be possible in the three position of separate local-off remote selector switch, which is also to be mounted on M.O.V.

Local - Open / Close/Stop, OFF - No electrical Operation
Remote - Open / Close /Stop from remote.
Handwheel – For manual operation. Handwheel shall be activated by means of a lever and the lever must declutch the motor while the MOV is operated in manual operation.

The continuous position indicators shall continuously indicate the position of travel of the valve.

Following protection and feature shall be integrated within MAV/MOV assembly.

- Motor overload protection
- Phase discriminator shall be provided to protect reversal of the direction.
- Torque limit selector switch

3.5.1.2.19 Neutral Grounding Resistor

The Neutral Grounding Resistor System shall be designed and tropicalized to withstand the site conditions as specified in the bid package.

Resistors element shall be made of unbreakable, corrosion proof, jointless stainless steel grids.


The resistor shall be sized for carrying the rated current for 10 seconds with maximum temperature limited to 790° C as per IEEE-32. Rated current shall be calculated as per IEC 61892-2.

The resistors shall be housed in a metal clad, totally closed enclosure. It shall be vermin proof and suitable for indoor installation. The enclosure shall meet the requirements of IP-51/NEMA-12. The enclosure thickness shall not be less than 3 mm.

The NGR shall be natural air cooled and any type of forced cooling shall not be used. However, if required, louvers can be provided in the enclosure.

The NGR shall be monitored continuously. OR, (Suitable earth fault leakage relay and alarm for failure of NGR shall be provided).

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3.5.1.2.20 Protection systems

The protection system provides adequate safeguards against the effect of any fault occurring on the system or component parts.

All protective devices, including relays and current transformers (CTs) etc. are to be adequately rated to withstand the prospective short circuit current, which can flow or be induced.

Unrestricted over current relays provided shall have IDMT characteristics of the standardized type A, B or C in accordance with IEC 60255-4.

The relay protection devices are such that a clear indication is given of the fault which caused a trip. Circuit breakers should not be able to re-close without first resetting the appropriate master trip relay.

3.5.1.2.21 Generator Protection

As a minimum, the following types of protection shall be provided for main GTG powered generating sets:

- 1) Voltage controlled inverse time over current relay.
- 2) Over current relay.
- 3) Differential current relay.
- 4) Directional (reverse) power relay.
- 5) Field failure relay
- 6) Over voltage relay
- 7) Under voltage relay
- 8) Frequency relay
- 9) Negative phase sequence relay
- 10) Earth fault alarm.

The LV emergency generator incomer shall have the following protection:

- 1) inverse time over current relay
- 2) earth fault alarm relay
- 3) under voltage relay
- 4) over voltage relay
- 5) reverse power relay

The LV emergency generator (more than 1000 kW) incomer shall additionally have differential protection in addition to those mentioned above.

When any prime mover trip parameter is exceeded or when the associated differential current relay actuates, Generators shall be disconnected from the main supply by tripping their associated circuit breaker and removing its field excitation. Simultaneously, the prime mover shall also be tripped.

Generator protection shall remain effective even if the frequency is reduced substantially.

3.5.1.2.22 Transformer Protection

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In all power/distribution transformers, in addition to differential protection following protections shall be provided as a minimum.

Primary (HV) side

- Over current with time delay and instantaneous trip.

Secondary (LV) side

- Earth fault
- Over temperature alarm and trip of downstream circuit breaker, providing over load protection.

Inter tripping shall be provided between HV and LV breakers to ensure complete isolation of the transformer under fault condition and inhibit close.

3.5.1.2.23 Motor Protection

LV motor starters shall have the following protective devices –

- MCCB for Short circuit.
- Single phasing protection.
- Earth fault protection.
- Overload.
- Intelligent communicable motor protection relays for three phase motors of 30 kW and above

HV motor panels shall have the following protective devices


- Over current
- Earth Fault
- Motor protection relay with negative sequence and locked rotor protection
- Differential protection for 1.5 MW and above
- Under voltage

3.5.1.2.24 Feeder Protection

LV Feeder Protection

ACB / MCCBs used for LV feeders shall have short circuit, Earth fault and over load protective devices. Earth leakage protection shall be provided for all MCBs.

MCCBs / MCBs used for DC incomer feeders and DC distribution feeders are to be provided with short circuit and overload protections as a minimum.

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HV Feeder Protection

- Over Current
- Earth Fault

Bus differential Protection shall be provided for main HV switchboard.

Cable connecting two HV switchboards located at different platforms in the same process complex shall be provided with differential protection.

3.5.1.2.25 Back up Protection

Time and time- current grading of up stream protective devices provide back up protection. The design features are such as to clear a fault in a total clearance time of 0.5 seconds if the primary protection fails to clear a fault for any reason.

3.5.1.3 DOCUMENTATION

3.5.1.3.1 Documentation during Engineering (Engineering Deliverables)

3.5.1.3.1.1 Categorization

Based upon the criticality, Engineering deliverables shall be divided into following categories. (Based upon the criticality Engineering deliverables shall be categorized as per general design criteria)

A. Approval

B. Review.

C. Information.

In general, the following drawings / Documents shall be under approval category.

Purchase specifications

Equipment sizing and lighting calculations

Hazardous Area classification drawings

Switch gear room lay outs


Single line diagrams

3.5.1.3.1.2 Contents

3.5.1.3.1.2.1 Electrical equipment Data Sheet

The data sheet shall include but not limited to the following.

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- Manufacturer name.
- Model/type
- Standard and code reference
- Electrical parameter Details
- Construction Materials details
- Performance details
- Mechanical/ physical Details
- General arrangement drawing showing electrical equipment and details of interface.
- Test certificate
- Hazardous area classification and certificate details (type of protection, certifying authority.)

A duly filled data sheet shall be provided by contractor for Company approval for every item of electrical equipment, including those which are part of packaged plant. When a number of items are identical in their requirements, these can be covered by a single specification sheet, provided all tag numbers are clearly listed.

3.5.1.3.1.2.2 Purchase specifications

The Purchase Specification (PS) submitted for Company’s review / approval shall have the following documents as a minimum:

- i) Top sheet identifying the document number, and duly signed by the Contractor.
- ii) Form B - Deviation schedule – duly signed by the Vendor and Contractor. (Typical, blank Form B is given in Annexure V)
- iii) Form C – List of Commissioning Spares – duly signed by the Vendor and Contractor (Typical, blank Form C is given in Annexure VI)
- iv) Form D – List of One year spares – duly signed by the Vendor and Contractor (Typical, blank Form D is given in Annexure VII)
- v) Form E – Inspection Requirement Table – duly signed by the Vendor and Contractor
- vi) Equipment specifications
- vii) Catalogues
- viii) Duly filled data sheets, signed by the vendor
- ix) Test certificates
- x) Functional schematic (as applicable)
- xi) Bill of material / material take off
- xii) QA / QC Plan

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The list of Purchase specifications is generally decided in consultation with contractor during detailed engineering. However, Purchase specifications of the following equipment as a minimum shall be prepared by the contractor and submitted to Company for approval;

- 1) Main and Emergency Generators
- 2) HV / LV switchgear and HMI
- 3) Power and Lighting Transformers
- 4) Lighting fixtures
- 5) Navigational aids with obstruction lights
- 6) UPS system
- 7) Battery and battery chargers
- 8) Telephone system
- 9) PAGA system
- 10) CCTV system
- 11) CP system
- 12) Cables
- 13) Heat Tracing


3.5.1.3.2 As Built Documentation

The Contractor shall provide the following documents as a minimum:

- Design and calculation books.
- Operating philosophy of the system and proposed maintenance schedule of all major components, for the design life of the system including replacement requirements of parts.
- Approved Purchase specifications
- Specifications, test certificates, Bill of materials and data sheets for all non Purchase specification items.
- Anode location drawings.
- Single line diagram, schematic diagram and functional wiring diagram of Switch gear and all DC panels.
- Cable and tray routing drawings and cable schedule.
- Earthing layout.
- Lighting fixtures, and obstruction light layout drawings.
- Interconnection and hook up drawings.
- MCT frame drawing.
- Equipment layout drawing in switch gear room
- Battery / Battery rack layout

3.5.1.4 Package Equipment

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Following is the list of Electrical packaged equipment: -

All the Major items indicated in the List against each package to be selected from the Suggested Vendor list of the Company.

S. No.	Packaged Item	Major items within package to be selected from ONGC suggested vendor list
1.	Turbine Generator Set	i) Gas Turbine ii) Alternator
2.	Solar Power system	i) Batteries bank ii) Solar Charge Controller iii) Solar Panels
3.	Uninterrupted Power Supply (UPS) system	Batteries bank
4.	Diesel Generator package *	i) Diesel Engine ii) Alternator
5.	Battery and battery charger system	i) Batteries bank ii) Battery charger

* Applicable for Emergency DG package

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Prepared / Revised By	Reviewed By	Approved By	Total No. of Pages	Date	Rev. No.
A. M.	P.K.	A.K.S.	17	19.03.2019	9

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3.5.2.1 General

The Electrical Design Criteria broadly outlines the design philosophy, methodology and documentation requirement for a solar power connected well head platform. Project specific requirement of the electrical system is provided in basic bid work enclosed with the Bid.

3.5.2.2 Design Philosophy:

3.5.2.2.1 The electrical system on an offshore well platform is designed to provide

- Safety to personnel and equipment
- Reliability of service
- Minimal fire risk
- Operational flexibility
- Optimization of available space
- Ease of maintenance and convenience of operation

3.5.2.2.2 Electrical Equipment / Material Selection

Materials shall be selected with regard to the following:

- Functional specifications and design criteria for each electrical items of this project.
- All applicable standards and codes.
- Reliable & trouble free performance.
- Safety of personnel, plant and minimal fire risk.
- General operating conditions.
- Compatibility with area classification of the place of installation.
- Suitability for the corrosive effects of the saline and humid marine atmosphere.
- Galvanic compatibility between dissimilar materials, with isolating bushes, plates, used where necessary to prevent corrosion due to galvanic action.
- All materials and equipment furnished shall be as per relevant standards, new and unused and of the highest grade and quality available for the required service and free of defects.

The equipment shall be protected from construction damage, damage in transportation and damage due to sandblasting and painting. The Electrical equipment enclosures shall have anti-corrosion protective coating as per requirement of “Protective Coating General Specification

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number 2005” with epoxy painting. The hard wares shall be high tensile MS duly cadmium plated/ Stainless Steel.

As a minimum material/equipment requirement shall be as follows.

- Cable ladders and trays shall be fiberglass Reinforced Plastic and UV protected.
- Associated accessories shall be SS316.
- Explosion proof junction boxes, light fitting, control stations etc. shall be manufactured of copper free aluminum alloy with an epoxy finish / SS-316.
- Hardware shall be of stainless steel.
- Cable glands shall be nickel plated brass double compression type or equivalent.
- All lighting shall be LED type.

3.5.2.2.3 Codes & Standards

The specification of design requirements, materials and system performance shall be supplemented by the requirements of the latest version of all applicable international Standards, Codes, regulation and code of practice some of which are outlined below. However compliance to P & NG Rule 2008 is a statutory requirement.

IEC	International Electro Technical Commission
NEMA	National Electrical Manufactures Association (USA)
ASTM	American Society for Testing and Material (USA)
NFPA	National Fire Protection Agency (USA)
IALA	International Association of Light house Authority
BSI	British Standards Institution
ANSI	American National Standards Institute
API	American Petroleum Institute(USA)
NEC	National Electric Code(USA)
SOLAS	Convention on safety of life at sea.
NESC	National Electric Safety Code (USA)
BIS	Bureau of Indian Standards
DNV	Dets Norske Veritas
NACE	National Association of Corrosion Engineer (USA)
MARPOL	Marine Pollution Act



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CENELEC European Standards published by CENELEC.

ATEX *Appareils destinés à être utilisés en ATmosphères EXplosibles.*

IEEE Institute of Electrical & Electronics Engineers

3.5.2.2.4 **Site Conditions**

All electrical equipment and accessories / material shall be suitable for installation and operation under extremely saline, humid, corrosive and hostile marine environment with specified degree of hazards including H₂S (wherever required).

In general, all outdoor electrical equipment shall be designed for 40°C temperature and maximum 90% relative humidity while the indoor equipment shall be designed for 45°C temperature and maximum relative humidity of 90%.

3.5.2.2.5 **Degree of Protection**

The enclosures for outdoor equipment are to be classified to IP-56 as a minimum degree of protection, increased as necessary where the location/situation demands. Indoor equipment, where ever not specified in their respective Functional specifications, will have a minimum of IP 41 protection and accessible equipment within enclosures will be a minimum of IP-20 degree of protection. Where indoor has specific ventilation requirement lower ingress protection rating may be considered subject to evaluation.

3.5.2.2.6 **Hazardous Area Requirements**

- The hazardous area classification shall be carried out in accordance with API-RP-500/ API RP505.
- The hazardous area classification drawing shall be the basis of selection of electrical equipment for various locations.

3.5.2.2.7 **Design Life**

The electrical equipment shall be designed for specified operating life of platform.

3.5.2.3 **Design Methodology**

3.5.2.3.1 **Solar Power System**

- The solar power system shall be designed as per functional specification 4007A solar power system.

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- An electrical load list shall be developed by the contractor based on the data sheet DS 4007A Solar power system as applicable. A margin of 10% shall be kept for future load growth. Based on this, total load, energy consumed per day shall be calculated and battery and solar panel sizing, cable sizing, switch gear sizing shall carried out.
- The solar power system shall be self-sustained type. The system shall be sized for seven (7) 'NO SUN' days and at the end of the 7 'NO SUN' days the batteries shall be recharged while also feeding the load. An additional margin of 5 %shall be kept for sizing of solar panels.
- Following lighting loads shall be considered for three hours every day.
 - i) 24 V DC, 2 nos. of LED lamp suitable for Class 1, Div 1 applications with two pole on/off switch in switchgear/electric room.
 - ii) 24 V DC, 2 nos. of LED lamp suitable for Class1, Div 1 applications with two pole on/off switch in Battery room.
 - iii) 24 V DC, 2 nos. of LED lamp suitable for Class1, Div 1 applications with two pole on/off switch in shelter room / bunk house.
 - iv) 24 VDC 1 no. LED lamp suitable for Class1, Div 1 applications with two pole on/off switch in Toilet room (wherever provided).
- Initial charging of all the batteries shall be carried out by Contractor. All necessary equipment for initial charging shall be arranged by the Contractor.

3.5.2.3.2 CABLES

3.5.2.3.2.1 General

The cable shall be as per detailed requirements of Power & Control Cable Functional Specification number FS 4011.

Cables for F&G and Navigational Aids system (From Battery bank to controller to DC DB to Nav-aid / F&G Detectors) shall be fire rated insulation (750 degree centigrade for 3 hours) and shall confirm to IEC 331 and 332.

Field cable joints shall not be permitted.

Special care shall be taken to the routing and separation of cables to minimize the effect of fire on emergency and essential supplies and production operations. All cables shall be identified with SS316 Tags.



In addition the minimum distance between power/control wiring and electronic signal wiring on prolonged cable route will be as follows:

<u>Power /control cable</u>	<u>Minimum distance from electronic/ signal cable</u>
Up to 125 volt	150mm

3.5.2.3.2.2 Cable Sizing

During detailed engineering all power cables shall be identified and sized according to the requirement of Indian and International standards. All the cables for AC/DC loads shall be sized individually satisfying all the following criteria:

- Current carrying capacity.
- Voltage drop steady state.
- Voltage drop limit during starting of motor.
- Short-circuit temp rise.

Where ever possible main power cables should be run with sufficient spacing in cable tray to minimize de rating due to grouping.

For incoming feeders, branch circuits and feeders for motors and lighting power, conductor current rating shall be established on the basis of 125% of design load current at an ambient temperature of 40 degree centigrade and de-rated for grouping and method of installation. The voltage grade of LV power and control cables shall be min 600 / 1000 volt.

3.5.2.3.2.3 Voltage Drop

The system nominal utilization voltage level shall be 48/24/12 volt DC.

The maximum allowable voltage drop in any feeder under steady state conditions shall be 2.5%.

3.5.2.3.2.4 Earthing

Earth cable shall be stranded copper conductor with PVC insulated and green / yellow insulation sheath.

Earth conductor requirement shall be as per cable specification number FS 4011.

Plant earthing shall be as per API- RP-14F.

The minimum size of earth bonding conductors on local control station enclosures shall be 16mm². The minimum size of earth conductors for electrical panels shall be 16 mm².



Vessels, tanks, and mechanical packages not directly welded to the structure shall be bonded to a structural earth pad or boss using at least two independent 70 mm² conductors.

In case if metallic cable trays are used, they shall be suitably earthed. Items such as pipes and duct work that have insulating material (i. e. gasket) between connected sections shall be made electrically continuous by bonding with a 6 mm² earthing cable or equivalent earthing strip.

All electrical panels shall be provided with a tinned copper earth bar.

3.5.2.3.2.5 Cable support System

The cable system shall comprise cable installed on cable tray or ladder with 25% spare capacity for future extension.

Intrinsically safe circuit cables shall be in separate tray.

Conduit systems shall not be used.

Cable straps or ties shall be SS316.

3.5.2.3.2.6 Cable tray /Ladder

Two primary cable tray /ladder system shall be installed.

- Low voltage power and control cable.
- Instrumentation, control and ESD.

Cable ladders /trays shall be manufactured from FRP and shall be UV protected.

Cable ladders shall be fitted with removable, ventilated covers where there is exposure to chemical spillage, falling object or direct sunlight. The covers and tray support will be suitable to withstand cyclone/monsoon conditions.

Cable tray shall be installed in accordance with manufacturer's recommendations and specifically supported at each elbow. The overhead cable trays shall be installed at a minimum height of 2.5 m meter above deck.

The cable tray and ladder shall be as per the requirements of FRP tray functional specification number FS4005.

3.5.2.3.2.7 Cable Glands and Transit Frames.

Suitable size double compression type glands shall be supplied for all cables. For entries into Ex(d) enclosures, barrier type (or compound filled) gland shall be provided. All cable glands



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and adaptors will be made of nickel-plated brass and shall be fitted with soft sealing nylon washer. Fiber washers shall not be used.

Lock nuts shall be used for entry into sheet steel boxes enclosures.

All cable glands shall be type tested and certified for use in hazardous area equipment.

Cable transit frames shall be fitted where cables pass through:

- From closed room to open air through deck or wall
- Fire / blast walls.
- From safe to hazardous area.

Such cable transit frames shall include 25% spare capacity for future use.

Cable transit frames shall be supplied with a test certificate from an accredited independent test authority to confirm a fire and blast rating adequate for deck or wall in which it is installed.

3.5.2.3.2.8 Junction Boxes- Cable Entry via Glands.

Junction boxes for use in outdoors shall be certified for use in Class I Division I and T3 hazardous area and fabricated from the copper free aluminum. It shall be Epoxy coated and have marine grade paint finish.

The terminals shall be pressure or clamp type and they shall be anti-vibration and anti-loosening type.

The junction box shall be as per the requirements of light fitting and Junction box functional specification number FS 4006.

3.5.2.3.3 Navigational Aids System

The navigational aids lantern shall be provided as per FS 4003. Solar system shall be provided as per FS 4007 A. The battery bank shall be sized for back up supply for case of 7 “NO – SUN” days.

3.5.2.3.4 Lightning Protection

As the method of construction shall incorporate bonded metal structure, no specific lightning protection shall be needed.

3.5.2.3.5 Plant Layout

The Contractor shall install electrical equipment only as per approved equipment layout drawing, with due consideration of the following:

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- Positioning of equipment (outdoor and indoor) shall not constitute a safety hazard.
- Visibility and accessibility for both maintenance and operations purpose.
- Light fixtures shall be fitted so that they can be serviced and removed by a single person.
- Cables and cable ladder shall not be fixed to gratings or handrails.
- Stainless Steel tags are to be provided for Cable near terminations, while passing through walls / MCT or one deck to another and at each bend.
- Cables shall be properly tied in FRP cable trays at 600/800 mm interval.
- Overhead Cable tray height must be minimum 2.5 meters for safety and convenience.

For convenience and ease in maintenance as well as operation, the minimum clearance between electrical equipment or between other items and electrical equipment shall be as tabulated below:

<u>Distance</u>	<u>Item description</u>
1200 mm	Frequent access (primary escape route)
1000mm	Infrequent access (secondary escape route)
1500mm	Minimum access between operating faces of floor mounted Switch-gear (MCC) panel.
1000mm	Rear clearance of panel requiring maintenance from rear.
150mm(Max)	Rear clearance for panels having only front access.
1000mm	Front clearance for wall mounting equipment.
800mm	Headroom clearance for MCC Panel, DC power panel etc.

Battery rack to wall clearance for following arrangements:

100 mm	Single row, single/double tier
100 mm	Double row, single tier
750 mm	Double row, double tier
750 mm	Rack to rack front clearance
< 150 mm or > 750 mm	Rack to rack side clearance

Electrical room (Switchgear room) shall be located in safe, non-hazardous and well-ventilated area.

- a) All equipment such as solar power controllers, lighting, DC power 48/24 volts & miscellaneous distribution boards Gas detection panels etc. shall be located in closed

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electrical room ventilated with louvers and shall be designed considering inadequate ventilation in the room.

- b) All batteries shall be located in closed battery room ventilated with louvers. The room will be located in safe area. Batteries shall be designed considering inadequate ventilation in the room.

All electrical equipment shall be installed in a neat workman like manner for ease of operation and maintenance and from safety viewpoint.

3.5.2.3.6 Miscellaneous Requirement

Outdoor equipment and required to be powered during an emergency shall be certified for class-I division-I and Temp. class T3 regardless of their location. All other electrical equipment shall be classified according to the location. However, all the outdoor electrical equipment except power generating equipment on oil / gas platform shall at least be suitable for Class I, Division II, gas group D area unless otherwise specified.

The equipment/items installed in battery room shall be suitable for class I Division I, Gas group B area with Temp. class T3.

3.5.2.3.7 Cathodic Protection

3.5.2.3.7.1 Cathodic Protection for Offshore Structures

The electrical requirement of cathodic protection system are to be read in conjunction with description of work and specification for jacket, PLEM etc. given elsewhere in bid package. It shall be without monitoring. The design life of CP system shall be the specified life of facilities i.e. Jacket, PLEM, SPM etc.

The CP system shall be in accordance with the requirement of ONGC functional specification number FS 4001.

3.5.2.3.7.2 Cathodic Protection pre- installed Risers and I/J tubes

The electrical requirements are to be read in conjunction with the description of work and specification for submarine pipelines and risers given elsewhere in bid package. The Design life of CP system shall be the specified life of platform.

The CP system for pre-installed risers and I/J tubes shall be in accordance with the requirement of ONGC functional specification number FS 4002.



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3.5.2.3.8 Light and Power Panels

Light and AC/DC power distribution board shall be of heavy duty sheet steel enclosure construction for installation in non-hazardous area (inside electric room).

The board shall be constructed in accordance with Indian and international standards.

Each board shall be equipped with an incoming isolator (MCCB), chassis mounted bus bar system and MCB or MCCB (with RCCB for Booster charger AC distribution systems) for power distribution. 20% spare feeders shall be provided. An earth bus shall be provided with each board and shall be fitted with suitable ring type lugs for all outgoing circuits.

In general any circuit feeding equipment located in hazardous area shall utilize circuit breakers that break all poles. The board /panel shall be as per the requirements of panel board functional specification number FS4004.

3.5.2.4 DOCUMENTATION

3.5.2.4.1 Drawings / Documents

The contractor shall generate the following drawings and submit to company for approval.

- Hazardous area classification drawings.
- Deck Layout drawings showing electrical room & battery room size & location.
- Electrical equipment layout, battery layout in electrical room/battery room.
- Earthing layout diagram.
- Cable and tray layout / routing, Cable Schedule.
- Navigational lantern layout.
- Solar panel layout.
- Anode Location Drawings.
- Single Line Diagram, Schematic Drawing and Functional Wiring diagram of LV Switchgear and all DC Panels.
- Lighting fixtures, solar panel and obstruction light layout drawings.
- Interconnection and hook up drawings.
- MCT frame drawing.
- Battery /Battery rack layout
- Engineering, Design and calculation books.

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- Operating philosophy of the system and proposed maintenance schedule of all major components, for the design life of the system including replacement requirements of parts.
- Specifications, test certificates and data sheets for all items.
- Deviation schedule for items if any.
- Bill of materials.

Any other drawings/documents required to make the electrical system complete and operational but not mentioned here shall be developed by contractor.

3.5.2.4.2 Calculations:


The Contractor shall provide calculations for electrical equipment's size, rating, power, capacity, quantity etc of the electrical equipment with reference to relevant codes and functional specification.

The electrical equipment and materials shall include but not limited to the following:

- Sacrificial anode for cathodic protection system of offshore structures and pre- installed IJ Tubes and risers.
- Battery Bank
- LV switch gears DC power panels.
- Power and control cable.
- Lighting fixtures and accessories.
- Cable tray, Ladder.
- Solar panel along with accessories, solar power controller, Nav. Aid battery and obstruction light.
- Earthing cable and conductor.
- MCTs frames.
- Any other equipment and accessories to make the electrical installation complete in all respect.

These shall form part of the relevant Purchase Specification to be submitted during Detailed Engineering. Vetting is to be done by the company or an agency approved by the company.

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3.5.2.4.3 **Electrical Equipment Index:**

The contractor shall provide an electrical equipment Index.

The index shall include the information listed below:

- Electrical Tag Number.
- Service Description.
- Rating/type.
- Electrical drawing (single line, schematic and wiring Drawing) Number.
- Data Sheet Number

The electrical index shall form the basis for documenting all electrical drawing and shall be listed in alphanumeric order of electrical tag number and shall contain all relevant information for each electrical item. The index shall be based on Microsoft Access.

3.5.2.4.4 **Electrical equipment Data Sheet:**


A duly filled data sheet shall be provided by contractor for every item of electrical equipment, including those which are part of packaged plant. The data sheet shall include but not limited to the following:

- Manufacturer name
- Model/type
- Standard and code reference
- Electrical parameter Details
- Construction Materials details
- Performance details
- Mechanical/ physical Details
- General arrangement drawing showing electrical equipment and details of interface.
- Test certificate
- Hazardous area classification and certificate details (type of protection, certifying authority.)

When a number of items are identical in their requirements, these can be covered by a single specification sheet, provided all tag numbers are clearly listed.

The Contractor shall submit his proposed data sheet for Company approval.

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3.5.2.4.5 Purchase specifications

The Purchase Specification (PS) submitted for Company's review /approval shall have the following documents as a minimum:

- i) Top sheet identifying the document number, and duly signed by the Contractor.
- ii) Form B - Deviation schedule – duly signed by the Vendor and Contractor.(Typical, blank Form B is given in Annexure V)
- iii) Form C – List of Commissioning Spares – duly signed by the Vendor and Contractor (Typical, blank Form C is given in Annexure VI)
- iv) Form D – List of One year spares – duly signed by the Vendor and Contractor (Typical, blank Form D is given in Annexure VII)
- v) Form E – Inspection Requirement Table – duly signed by the Vendor and Contractor
- vi) Equipment specifications
- vii) Catalogues
- viii) Duly filled data sheets, signed by the vendor
- ix) Test certificates
- x) Functional schematic (as applicable)
- xi) Bill of material / material take off
- xii) QA / QC Plan

The list of Purchase specifications is generally decided in consultation with contractor during detailed engineering. However, Purchase specifications of the following equipment as a minimum shall be prepared by the contractor and submitted to Company for approval:

- 1) Solar Power system
- 2) Nav Aid system
- 3) CP System.
- 4) Boost Charger (if specified in Bid).
- 5) Any other major items specified in the Bid Package.

3.5.2.4.6 As Built Documentation

The Contractor shall provide the following documents as a minimum:

- Design and calculation books.

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- Operating philosophy of the system and proposed maintenance schedule of all major components, for the design life of the system including
- Replacement requirements of parts.
- Approved Purchase specifications
- Specifications, test certificates, Bill of materials and data sheets for all non-Purchase specification items.
- Anode location drawings.
- Single line diagram, schematic diagram and functional wiring diagram of all DC panels.
- Cable and tray routing drawings and cable schedule.
- Earthing layout.
- Lighting fixtures, and obstruction light layout drawings.
- Interconnection and hook up drawings.
- MCT frame drawing.
- Equipment layout drawing in switch gear room
- Battery / Battery rack layout

3.5.2.4.7 The contractor shall provide hard copies plus electronic copies on CD for all the documents. Minimum 3 (three) sets of Dossier shall be provided to the Company.

The contractor shall be responsible for the authenticity of the drawings & data provided by the vendor as well as sub-vendor(s).

Each vendor data items requested above must be identified by the Purchase Order number and equipment tag number located on the cover sheet or first page of said item and in the case of engineering drawings on each and every drawing.

Any additional data/drawings required, as a result of issuing supplements to a purchase order or during detailed engineering, shall be furnished by Vendor and handled in the same manner as the original order.

All drawings and literatures shall be in English language and in the Metric Measurement System.

The reproducible drawings, 279mm X 432mm (11" x 17") size and full size are to be of such quality that clear legible prints can be made.

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3.5.2.4.8 Tagging and Name Plates:

All equipment (Motors, push buttons, motor control centers, push button stations, junction boxes, etc.) shall have SS tag or nameplate of a permanent type with identification number and service description.

The tag number that pertains to an electrical equipment shall appear on all drawings and documents approved by company.

Nameplates and identification tags shall be provided to properly identify each piece of electrical equipment.

All panel electrical equipment nameplates shall be constructed of white laminated plastic plates with black engraved lettering and securely fastened with 316 SS screws.

All front panel mounted equipment shall also be identified with a metal or plastic nameplate attached to the rear of the device, and easily visible via the rear access doors.

All wiring, power and control cables, junction boxes, terminal blocks and auxiliary equipment shall be suitably identified as per applicable codes and practices. Plastic adhesive tapes shall not be used for identification. All wiring shall be tagged with slip on or clip-on wire marker at both ends, with the wire number specified on the drawing as per company's established identification system.

3.5.2.4.9 Electrical Equipment Inspection & Testing Philosophy:

The Contractor's quality plan shall include a comprehensive fully documented inspection and testing plan specific to the project and it shall be submitted to company for review and approval.

The Contractor shall provide suitable workshop, equipment and facilities to carry out all necessary tests for the electrical equipment.

The Company reserves the right to reject any or all test work if the same is not in line with requirement of relevant specification.

The Contractor shall, in the presence of the Company Representative, verify by inspection and testing that, all electrical equipment in field and control room including local and remote/central control panels is complete and operable. All testing shall be subject to approval of the Company.

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All Electrical equipment need to be checked and certified prior to shipment by company rep. and / or company approved certifying agency.

In addition to yard testing of loop checking and setting for safety devices like overload relays and Instantaneous trip relay, simulation testing of all interlock and shutdown systems etc., also shall be carried out at offshore.

Verification shall be carried out that grounding points are installed properly.

Insulation test shall be carried out on all cabling by using a meggar of 500 volt DC. It should not be less than 10 M ohm for LT system.

Correct connections of all electric equipment shall be checked.

All testing and pre-commissioning shall be done by the Contractor. The Contractor shall also provide assistance as required to assist the Company's commissioning activities.

The Contractor shall submit the results of all above tests to the company and if required by the Company, the contractor shall provide reasonable evidence of the satisfactory condition of test equipment.

3.5.2.5 Package Equipment

Following is the list of Electrical packaged equipment: -

All the Major items indicated in the List against each package to be selected from the Suggested Vendor list of the Company.

S. No.	Packaged Item	Major items within package to be selected from ONGC suggested vendor list
1.	Turbine Generator Set	i) Gas Turbine ii) Alternator
2.	Solar Power system	i) Batteries bank ii) Solar Charge Controller iii) Solar Panels
3.	Uninterrupted Power Supply (UPS) system	Batteries bank
4.	Diesel Generator package *	i) Diesel Engine ii) Alternator
5.	Battery and battery charger system	i) Batteries bank ii) Battery charger

* Applicable for Emergency DG package

Instrumentation Design Criteria

OIL AND NATURAL GAS CORPORATION LTD.

MUMBAI

PREPARED	CHECKED	APPROVED	PAGES	DATE	REV. NO.
<i>Rohini Goreva</i> <i>8/6/23</i>	<i>YD</i> <i>8/6/23</i>	<i>SA</i> <i>08/06/23</i>	59	08.06.2023	09
RS	YD	SA	59	08.06.2023	09
SSK/VKS	ARD	KM	43	06.09.2016	08
SRS	ARD	AKR	41	31.08.2012	07
SRS	ARD	AKR	41	28.11.2011	06
SRS	ARD	AKR	40	22.01.2010	05a
SRS	ARD	AKR	40	08.12.2009	05
RS/ BK	S.S.K	G.R.P	36	06.02.2008	04
VB	BK	G.R.P	70	03.12.2007	03
ET	MC	RK	63	21.06.2005	02
E.T.	M.C.	R.K.	63	10.01.2005	01
E.T.	M.C.	A.C.	63	13.08.2003	0

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3.6.1 SCOPE OF THIS DOCUMENT

This document defines the Design Criteria for the Instrumentation and Control System envisaged for the Offshore Platforms/ Mobile Offshore Production Unit (MOPU)/ Packaged Equipment/ Free Issue Materials (FIM) etc. for design, selection, testing, installation and commissioning of the instrumentation systems. This Instrumentation Design Criteria (IDC) is a guideline and general in nature.

This document shall be read in conjunction with Basic Bid Work, Process and Equipment requirements, P&IDs, Functional Specifications (FS), System Architecture etc. to complete the Instrumentation Scope of Work (SOW), as applicable in the project.

09

3.6.2 PURPOSE OF INSTRUMENTATION

The purpose of Instrumentation is to provide a complete and safe monitoring, control and shutdown system for process and associated systems such that all the required information/ data/ signals are available in the desired form and place at Control Room and Monitoring Centers as envisaged in the scope of work in required form following the Basic Bid Work, P&IDs and the Functional Specifications in the tender document.

The intent of instrument specifications, data sheets and general guidelines is to provide the basic system requirements and establish a level of quality and service conditions.

09

3.6.3 STANDARDS AND CODES

Latest editions of the Codes/ Standards/ Specifications/ Recommended Practices (RP) enlisted below shall be followed as applicable:

American Gas Association (AGA)	
AGA Report 3	Orifice Metering of Natural Gas
AGA Report 7	Measurement of Gas by Turbine Meters
AGA Report 8	Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases
AGA Report 9	Measurement of Gas by Multi-path Ultrasonic Meters
AGA Report 10	Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases
AGA Report 11	Measurement of Natural Gas by Coriolis Meter
American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)	

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	ANSI B 2.1	Pipe Threads
09	B 16.5	Pipe Flanges and Flanged Fittings
	B 16.10	Face to Face and End to End Dimensions of Ferrous Valves
09	B 16.34	Valves – Flanged, Threaded and Welding End
	B 16.36	Orifice Flanges
09	ANSI FCI 70.2	Control Valve Seat Leakage
	ANSI MC 96.1	Temperature Measurement Thermocouples
	ANSI B 1.20.1	Pipe Threads, General Purpose
09	ASME PTC 19.3 TW	Performance Test Code on Thermowells
	ASME Section VIII	Sizing and Selection of Pressure Relief Valves
	American Petroleum Institute (API)	
	API SPEC 6D	Specification for Valves
	API STD 6FA	Standard for Fire Test for Valves
	API RP 14C	Analysis, Design, Installation and Testing of Basic Surface Systems for Offshore Production Platforms.
09	API RP 14F	Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1, and Division 2 Locations
	API RP 14G	Fire Prevention and Control on Fixed Open-type Offshore Production Platforms
	API RP 17A	Design and Operation of Subsea Production Systems - General Requirements and Recommendations
	API SPEC 17E	Specification for Subsea Umbilicals
	API RP 505	Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2
09	API RP 520	Design and Installation of Pressure-Relieving Systems in Refineries; Part I—Design Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries; Part II—Installation
	API STD 521	Pressure-relieving and Depressuring Systems
	API STD 526	Flanged Steel Pressure-Relief Valves

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09	API STD 527	Seat Tightness of Pressure Relief Valves
	API RP 551	Process Measurement
	API RP 552	Transmission Systems
09	API RP 554-1	Process Instrumentation and Control - Functions and Functional Specification Development
	API RP 555	Process Analyzers
09	API STD 598	Valve Inspection and Testing
	API STD 2000	Venting Atmospheric and Low-Pressure Storage Tanks
09	API MPMS	<p>API Manual of Petroleum Measurement Standards</p> <p>Chapter 1 - Vocabulary</p> <p>Chapter 4 – Proving - Guide for the design, installation, calibration, and operation of meter proving systems.</p> <p>Chapter 5 – Metering- Dynamic measurement of liquid hydrocarbons</p> <p>Chapter 6 – Metering Assemblies - Design, installation, and operation of metering systems for coping with special situations in hydrocarbon measurement</p> <p>Chapter 12 - Calculation of Petroleum Quantities</p> <p>Chapter 14 - Natural Gas Fluids Measurement - Standardizes practices for measuring, sampling, and testing natural gas fluids</p> <p>Chapter 20 - Allocation Measurement of Oil and Natural Gas</p> <p>Chapter 21 - Flow Measurement using Electronic Metering Systems</p> <p>Chapter 22 – Testing Protocols</p>
	American Society for Testing and Materials (ASTM)	
09	ASTM A269	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
	ASTM A276-316L	Stainless Steel Fittings
	ASTM 370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
09	ASTM 450	General Requirements for Carbon and Low Alloy Steel Tubes
	ASTM F 1387	Performance of Piping and Tubing Mechanically Attached Fittings
09	ASTM G48	Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steel

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British Standards	
BS 1904	Industrial Platinum Resistance Thermometer Sensors
BS 4937	International Thermocouple Reference Tables
BS 5501	Electrical Apparatus for Potentially Explosive Atmospheres
BS/ IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
BS EN 12874	Flame Arrestors
International Electrotechnical Commission (IEC)	
IEC 61000-4	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic Discharge Immunity Test Part 4-3: Testing and measurement techniques – Radiated, radio-frequency electromagnetic field immunity test
IEC 60079-11	Explosive atmospheres – Part 11: Equipment protection by intrinsic safety “I”
IEC 60092-373	Shipboard flexible coaxial cables
IEC 60092-359	Sheathing Materials For Shipboard Power And Telecommunication Cables
IEC 60227	Polyvinyl chloride insulated cables of rated voltages up to and including 440/ 750 V
IEC 60331	Tests for Electric Cables Under Fire Conditions – Circuit Integrity
IEC 60332-1	Tests on electric cables under fire conditions Part I: Tests on single vertical insulated wire or cable
IEC 60332-3	Tests on electric cables under fire conditions Part II: Tests on single small vertical insulated copper wire or cable
IEC 610 86-1	Coatings for loaded printed wire boards (conformal coatings) - Part 1: Definitions, classification and general requirements
IEC 61131-3	Programmable Controllers – Part 3: Programming languages
IEC 61508-1-7	Functional Safety on Electrical/ Electronic/ Programmable Electronic Safety-Related Systems
IEC 61511 Part-1 to 4	Functional Safety – Safety Instrumented Systems for the Process Industry Sector
IEC 60654-4	Operating Conditions for Industrial – Process Measurement and Control Equipment Part 4 - Corrosive and Erosive Influences
Institute of Electrical and Electronics Engineers (IEEE)	

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09	IEEE 472	Guide for Surge Withstand Capabilities (SWC) Tests
	IEEE C37.90.1	Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
09	IEEE 730.1	Guide for Software Quality Assurance Planning
	IEEE 828	Configuration Management in Systems and Software Engineering
	IEEE 1042	Guide to Software Configuration Management
Instrumentation Systems and Automation Society (ISA) Note: A lot of ISA Standards are adopted by ANSI and known as ANSI/ ISA Standards.		
09	ISA 5.1	Instrumentation Symbols and Identification
	ISA 5.4	Instrument Loop Diagrams
	ISA 7.0.01	Quality Standard for Instrument Air
	ISA RP 12.4	Pressurized Enclosures
09	ISA RP 12.6	Wiring Practices for Hazardous (Classified) Locations Instrumentation Part I: Intrinsic Safety
	ISA RP 42.00.01	Nomenclature for Instrument Tube Fittings
	ISA 50.02-2	Fieldbus Standard For Use In Industrial Control Systems Part 2: Physical Layer Specification And Service Definition
	ISA RP 60.1	Control Center Facilities
	ISA RP 60.2	Control Center Design, Guide and Terminology
	ISA RP 60.4	Documentation for Control Centers
	ISA RP 60.6	Nameplates, Labels & Tags for Control Centers
	ISA 51.1	Process Instrumentation Terminology
	ISA 12.13.01	Performance Requirements for Combustible Gas Detectors
	ISA RP 12.13.02	Installation, Operation and Maintenance of Combustible Gas Detection Instruments
	ISA 92.00.01	Performance Requirements for Toxic Gas Detectors
	ISA 92.00.02	Installation, Operation and Maintenance of Toxic Gas Detection Instruments
09	ISA 71.01	Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity
	ISA 71.04	Environmental Conditions for Process Measurement and

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	Control Systems: Airborne contaminants
ISA 75.01.01	Flow equations for sizing control valves
ISA 75.02.01	Control Valve Capacity Test Procedures
ISA 75.08.01	Face to Face Dimensions for Integral Flanged Globe Style Control Valve Bodies
09 ISA 75. 19.01	Hydrostatic Testing of Control Valves
ISA 100.11a	Wireless Systems for Industrial Automation: Process Control and Related Applications
ISA 18.1	Annunciator Sequences and Specifications
ISA 18.2	Management of Alarm Systems for the Process Industry
09 ISA TR84.00.02 Part 1 to 4	Safety Instrumented System – Safety Integrity Level Evaluation Techniques
ISA TR84.00.07 Part 1 to 4	Guidelines for Evaluating the Effectiveness of Fire, Combustible Gas and Toxic Gas Systems.
International Organization for Standardization (ISO)	
ISO 5167-1	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements
ISO 5167-2	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 2: Orifice plates
ISO 5167-3	Measurement Of Fluid Flow By Means Of Pressure Differential Devices Inserted In Circular Cross Section Conduits Running Full - Part 3- Nozzles And Venturi Nozzles
ISO 5167-4	Measurement Of Fluid Flow By Means Of Pressure Differential Devices Inserted In Circular Cross Section Conduits Running Full - Part 4-Venturi Tubes
ISO 5167-5	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 5: Cone meters
ISO TR 12748	Wet gas flow measurement in natural gas operations
ISO TR 11583	Measurement of wet gas flow by means of pressure differential devices inserted in circular cross-section conduits
ISO 13628-5	Petroleum and natural gas industries - Design and operation of subsea production systems - Part 5: Subsea umbilicals

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09	ISO/ IEC 17025	General requirements for the competence of testing and calibration laboratories
	ISO 17089-1	Measurement of fluid flow in closed conduits- Ultrasonic meters for gas - Part 1: Meters for custody transfer and allocation measurement
	ISO 17089-2	Measurement of fluid flow in closed conduits- Ultrasonic meters for gas - Part 2: Meters for industrial applications
National Association of Corrosion Engineers (NACE)		
09	ANSI/NACE MR 0175/ ISO 15156	Petroleum, Petrochemical and Natural Gas Industries- Materials for Use in H ₂ S-Containing Environments in Oil and Gas Production
	National Electrical Manufacturers Association (NEMA)	
09	ANSI/NEMA 250	Enclosures for Electrical Equipment (1000 Volts maximum)
09	National Fire Protection Association (NFPA)	
	NFPA 70	National Electrical Code (NEC)
	NFPA 1	Fire Code
	NFPA 72	National Fire Alarm and Signaling Code
	NFPA 86	Ovens and Furnaces
	NFPA 87	Fluid Heaters
	NFPA 496	Purged and Pressurized Enclosures for Electrical Equipment
	International Telecommunication Union (ITU)	
09	ITU-T Reco. G.650	Definition and test methods for the relevant parameters of single-mode fibres.
	ITU-T Reco. G.652	Characteristics of a Single-Mode Optical Fibre and Cable
	ITU-T Reco. G.655	Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable.
	ITU-T Reco. G.656	Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport.
09	Society of Automotive Engineers (SAE)	
	SAE J343	Test and Test Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies
Other Bodies		
Norsok Standards: U-CR-006 Sub-sea Production Control Umbilical		

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DIN Standards: DIN 3381: Safety Devices for gas supply installations, pressure relief governors and safety shut off devices.

Engineering Equipment Materials Users Association (EEMUA) publication No. 191, Alarm Systems – a Guide to Design Management and Procurement

Normenarbeitsgemeinschaft für Mess-und Regeltechnik in der chemischen Industrie (User Association of Automation Technology in Process Industries)-
NAMUR NE43: Standardization of the Signal Level for the Failure Information of Digital Transmitters

OISD: Oil Industry Safety Directorate relevant standards

All goods and services supplied shall meet all applicable local and international regulations on health, safety and environmental issues.

Note: In case of a conflict among various standards, the most stringent standard shall be followed.

3.6.4 INSTRUMENTATION SYSTEM PHILOSOPHY

3.6.4.1 INSTRUMENT PHILOSOPHY

3.6.4.1.1 Units of Measurement

Following units of measurement shall be used, unless otherwise specified:

Flow (Liquid)	Kg/hr, m ³ /hr
Flow (Gas)	Sm ³ /hr, MMSCMD
Temperature	Deg. Centigrade
Pressure	Kg/cm ² g
Differential Pressure	inch/ mm of Water Column

3.6.4.1.2 All electronic and pneumatic instrument systems shall be designed for “Fail Safe” operation.

3.6.4.1.3 All the offered instruments/ equipment or equipment of similar design manufactured shall have been:

a) Type tested by the accredited authority.

b) Of proven design.

c) Instruments, bulk materials, accessories etc., shall conform to the various relevant Functional Specifications.

d) The criteria, guidelines and specifications do not absolve the Vendor/ Contractor/ Packager of his responsibilities of providing the instruments with all necessary hardware, cards and accessories for proper measurement and display at field/ control room, computation, power supplies, transmission of data/ signals for proper operation and for the intended purpose.

e) OIML (Organisation of Legal Metrology) Certification shall be furnished where the measurements are for custody transfer applications.

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3.6.4.1.4 Field Instruments



- a) *Wellhead Platforms with Solar Power:* Field Instruments connected to Well-Head Control Panel shall be Pneumatic, unless otherwise specified in the scope of work for the project. The field instruments connected to RTU for monitoring, control, telemetry and remote control shall be electronic SMART type with HART communication protocol.
- b) *Smart Wellhead Platforms with External Power:* All field instruments for well monitoring and control shall be electronic SMART type with HART communication protocol.
- c) *Process Platform:* Instruments connected to the Control Room Panels and Unit/ Remote Control Panels shall be electronic SMART type with HART communication protocol.
- d) In modification jobs, wherever Foundation Fieldbus (FF) type Instruments are existing, new FF instruments shall be used only for monitoring purpose to match the existing philosophy, if specifically mentioned in the SOW. However, in control loops, only HART based instruments shall be used.
- e) In modification jobs, wherever Wireless type Instruments exist, new wireless instruments shall be used for monitoring purpose only, if specifically mentioned in the SOW.
- f) In general final control elements at field (located in the hazardous area) shall be pneumatic type. Hydraulic/ Electric actuators shall be provided wherever specified in the bid scope of work.
- g) Instrument ranges shall be selected such that the normal operating point is between 30% to 70% of span for linear scale and 60% to 80% of span for square root scale.
- h) If static pressure measurement for pressure compensation is required for a compressible fluid, it shall be taken upstream of the measuring element.
- i) Field switches and status alarms shall be electrical or pneumatic as per the scope of work.
- j) In an effort to provide standardization, it is the Contractor's responsibility to ensure that the various equipment/ package sub-vendors supply the same type and make of instruments and accessories. Vendor shall be responsible for complete design, sizing, installation and workability of the systems. Vendor specifications and relevant calculations/ sizing sheets shall be submitted along with Purchase Specification (PS) for Company's approval.
- k) Hand-held Intrinsically Safe universal type calibrator/ HART communicator/ Industrial Laptops/ Smart Tabs loaded with licensed software shall be supplied for online diagnostics, configuration or calibration of electronic instruments as per the quantities specified in SOW.



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3.6.4.1.4.1 Pneumatic Field Instrumentation

- a) The instrument air supply shall conform to ISA 7.0.01 “Quality Standard for Instrument Air”.
- b) Instrument Air/ Gas piping and branch connections shall be as per ANNEXURE-II attached in this document.
- c) Each pneumatic instrument supply shall be provided with independent filter regulator. For pneumatic instruments, dry instrument gas/ air supply shall be as follows :

Minimum	Normal	Maximum
5.5 kg/cm ² g	7.5 kg/cm ² g	10.5 kg/cm ² g

All related equipment shall be suitable for operating in the above specified range.

- d) For pneumatic control applications, the actuating signal range shall be 0.2 to 1 kg/cm²g or 0.4 to 2.0 kg/cm²g.
- e) For pneumatic On-Off applications, the actuating signal shall be 0 or 5.5 kg/cm²g, however the logic signal shall be 3.5 kg/cm²g.
- f) For platforms with sour gas service specified with “Electro - Hydraulic System”, the hydraulic power shall be utilized for control, logic and actuation to the extent envisaged in the project SOW and its P&IDs.

3.6.4.1.4.2 Electronic Field Instruments

- a) All Electronic transmitters shall be 24 VDC loop-powered type with 4-20 mA SMART analog output signal. Electronic Transmitters shall have inbuilt digital output LCD display in engineering units.

Where this is not possible, a suitable separate intrinsically safe local loop indicator/ display unit shall be provided.

All field transmitter enclosures shall be dual chamber type.

- b) All electronic transmitters shall be minimum SIL-2 certified.
- c) For monitoring and alarm, electronic transmitters with 4-20 mA output shall be used.
- d) In case of process platforms, electronic transmitters with 4-20 mA output shall be used instead of switches for trips. The ESD PLC shall convert the 4-20 mA signals into digital input for the intended application.
- e) All local electrical control and field alarm switches shall be hermetically sealed dual SPDT/ DPDT Microswitch activated switches having gold plated contacts.
- f) Shutdown, Blowdown and Deluge Valves shall be provided with Proximity type switches for valve position indication in RTU/ PCS/ DCS.

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- g) For Process Platforms and Smart Wellhead Platforms with External Power, all Solenoid Valves (SOV) and relays shall be continuous rated type. SOVs shall preferably be of universal type.

For solar-powered wellhead platforms, solenoid valves shall be pulse-operated type.

- h) All the electronic instrumentation systems shall be provided with lightening and spike/ surge protection circuits. The OEM's recommendations shall be adhered to for design and implementation of the "Earth" system.
- i) Unless otherwise specified in the scope of work for the project, signals for RTU shall be isolated 4-20mA DC for analog loops or dry contacts or isolated pulse signals as relevant to the service. These signals shall be terminated in RTU marshalling panel and made available in the RTU.

3.6.4.1.5 Control Room Instrumentation



- a) Centralized control and monitoring and data/ alarm/ event logging/ trending etc. for all field instrumentation and packaged equipment shall be done through Distributed Control System (DCS) in Process Complex, through RTU in solar powered wellheads and through Process Control System (PCS) in Smart Wellhead Platforms with External Power.

All the package instrumentation signals along with necessary serial/ digital communication interfaces, isolated 4-20 mA DC (load resistance minimum 500 ohms), isolated dry contacts, signals from Unit Control Panels (UCP) etc. as per SOW shall be provided by the Packager-Vendor.

- b) All signals to and from the Central Control Room shall be electrical/ electronic.
- The standard analog signal shall be 'SMART' 4-20 mA using 2-wire system, standard thermocouple, RTD output, and/ or suitable pulse signal etc.
 - The standard digital signal (inputs/ outputs) shall be 24 VDC.
 - Serial communication with packages and devices shall be as per Basic Bid Work.
- c) DCS shall be OPC enabled and shall be equipped with Antivirus and Firewall to protect the system against external intrusion or access. OPC requirements are specified in the Functional Specifications for DCS.
- d) If PLC based control system is envisaged for monitoring and control on Wellhead Platforms, then OPC enabled system shall be provided in HMIs. Communication of PLC with other system(s) shall be preferably Ethernet based and not on "proprietary" protocols. If PLC communicates on proprietary protocols, then *"in built" OPC enabling is mandatory* for such system. PLC shall be OPC enabled for reading/ writing into it from SCADA with secure communication.

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Associated HMI/ Master Terminal Unit (MTU)/ Workstations at Process Platform shall be OPC enabled for data transfer and connectivity to DCS/ SCADA.

- e) All platforms shall have Fire & Gas Detection System conforming to FS-3500 (Scheme A or B) and shall initiate ESD/ FSD signal for shutdown in case of confirmed gas/ fire.
- f) For Smart Wellhead Platforms with External Power, the PLC-HMIs shall continue to operate standalone, even in case of communication break down with the associated process platform.
- g) Process PLCs, Safety PLCs (ESD and F&G), UCP PLCs of packaged equipment etc. shall have provision of interfaces like MODBUS RS-485, TCP/ IP and Ethernet/ IP protocols for communication with other systems.
- h) Relays utilized in 24 VDC control logic circuits shall have gold plated contacts rated 0.5A at 24 VDC and shall be hermetically sealed. Those interfacing with field equipment shall be rated 24 VDC (2A)/ 110 VAC (5A).
- i) For Process and Wellhead platforms, all the electronic cards (CPU, Controllers, I/O, Power Supply, Communication etc.) and HMI of DCS, OPC servers, ESD PLC, F&G PLC, F&G Controller, High Integrity Pressure Protection System (HIPPS), Unit Control Panels (UCP) and Local Control Panels (LCP) of Packaged Equipment etc. shall be G3/ GX compliant with conformal protective coating (Harsh environment) requirements as per ANSI/ ISA 71.04, IEC 61086-1 and IEC 60654-4/ equivalent national or international standards.
- j) All instrument panels and cabinets in the safe area (Control room, Switchgear room, and pressurized rooms) shall be 'general purpose' enclosures with IP-42 protection or higher.
- k) Control Room having DCS and other control panels shall have air quality as per ISA 71.01 and ISA 71.04 standards.
- l) The DCS and PLCs shall be rated to perform, without being de-rated, in conditions arising out of absence/ failure of the HVAC, in the control room/ controlled atmosphere, for at least 8 Hours. Temperature may rise to 60°C in rooms housing the panels and cabinets.
- m) PLC shall be suitable for operating in temperature range of 0° C to 60° C and in Relative humidity of up to 99%.
- n) In order to remove dissipated heat effectively from the cabinets/ panels housing electronic cards, controllers and PLCs, suitable ventilation shall be provided by means of atleast two louvers with filters and ball bearing fans in the panels.
- o) All the system and marshalling cabinets for DCS, ESD PLC, Fire & Gas System, UCP, RCP etc. shall be free standing cubicles preferably with standard dimensions of 800/ 1200 mm x 800 mm x 2100 mm (W x D x H).



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Clear working spaces of 1000 mm in rear and 1500mm in front of the panels shall be provided for door opening and maintenance purpose.

Cabinets shall be placed such that aesthetics of the control room is maintained.

- p) Unit Control Panels (UCP) of packaged equipment shall be free standing and as per the equipment package Vendor's standards. For each unit, individual panel shall be preferred.

However, all the electronic signals from these UCPs e.g. DI, DO, AI, AO etc. shall communicate with the DCS/ RTU/ PCS or any HMI/ Control System located in the control room through serial or TCP/ IP interface for 'monitoring'. 'Trip' from platform ESD System to package UCPs shall be hardwired. Critical alarms to DCS from UCPs and start/ stop signals from DCS to UCPs shall also be hardwired.

- q) All front mounted user interfaces like displays, keypads, lamps, push buttons, selector switches etc. on Control Panels shall be arranged in a logical and aesthetic manner for easy visibility, operation and maintenance. User-interfaces shall be mounted above 750mm from the panel-base.

Each user interface on the front and rear side shall have a name plate indicating their description.

All lamps on Control Panels shall be provided with lamp test facility.

- r) All fused and non-fused DIN Rail Mounted Terminal Blocks (TBs) used in DCS, ESD and F&G system panels, marshalling cabinets and field junction boxes shall be screw less Push-in type to facilitate easy tool-less insertion of conductors. TB connection shall be designed to withstand deck vibrations for maintaining reliable contact.

Stacked type/ multi-tier TBs shall not be used.

The TBs shall be preferably of Phoenix/ Wago/ Weidmüller/ Allen Bradley make.

- s) Screw less Push-in type Busbar TBs (Wago or equivalent) shall be used for terminating 24 VDC or 110 VDC wire terminals or shield (screen) connections instead of Busbar plate in System and Marshalling Cabinets of DCS, ESD and F&G System.
- t) Nickel plated brass lugs shall be used for wiring terminations. The connecting wires shall have double cross ferruling using tube ferrules with source and destination marking on both ends.
- u) Bottom seal shall be used for cable entry in System and Marshalling Cabinets of DCS, ESD and F&G System in place of traditional cable glands/ gland plates to achieve easy, quick, light weight, flexible and high density cable installation. This removable Panel Cable Sealing System shall be designed to ensure bonding, grounding and EMI protection as per requirements of OEMs of DCS/ ESD/ F&G System. Sealing system Vendor

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shall be from Multi Cable Transit (MCT) Vendor list in Suggested Vendor List (SVL).

- v) MCT blocks shall be used for cable entry in the Control Room, TIC/ E&I Room, Non-pressurized equipment rooms, Enclosure area etc. as passive fire and pressure protection seal and shall be re-usable. It shall be designed to protect against fire, water, smoke, dust, gas, rodents and other hazards.
- w) Rechargeable Portable gas detectors shall be provided as per the quantity specified in the SOW.

3.6.4.1.6 Safety Instrumented System

In general, the following safety systems shall be provided:



- a) **Emergency Shutdown (ESD) System:** The ESD system shall initiate automatic process shutdown in case of abnormal condition of the specified process parameter.
- b) **Fire & Gas (F&G) System:** The F&G System shall initiate appropriate actions viz. alarms and/or shutdown upon detection of pre-set levels of Hydrocarbon (HC) and/ or H₂S accumulation and Fire. The F&G system shall conform to the Functional Specification FS-3500.

On Wellhead Platforms: Fire and Gas detectors, fusible plugs and ESD & FSD pull stations (Pneumatic/ Electric) shall be provided with Control Cards or PLC as per the scope of work.

On Process Platforms: SIL-3 PLC based Fire and Gas Detection System shall be provided. For details, refer FS-3500.

- c) **Manual ESD & FSD Stations:** The ESD & FSD stations shall be provided at all strategic locations on the platform for manual initiation of ESD or FSD. All the ESD & FSD stations shall be located in places which are accessible on main walkways and stairs and provided with Acrylic covers to prevent accidental actuations.
- d) **HIPPS** system shall be provided for pipeline protection and integrity, wherever specified in the Basic Bid Work.
- e) All shutdown and alarm switches shall be “Fail Safe” and the targeted abnormal conditions shall cause a loss of actuating signal to the final control element.



- f) Automatic trip circuits shall meet the following requirements:
 - i) Parameters used for shutdown shall be sensed by independent/ individual sensors at independent tapping points. Such sensors and tapping points shall not be shared by any other loop.
 - ii) All trips shall have a pre-warning alarm and an alarm to indicate the trip conditions.

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- iii) Adequate trip bypass facilities are to be provided with warning and visual indication in the operator console/ annunciation panel to indicate that the trip has been bypassed.

3.6.4.1.7 Optical Communication Cable



If Fiber Optic Cable is envisaged in Scope of Work for communication between Platforms/ Wellhead Platform to Main Process Platform, it shall comply following specifications as a minimum:

- a) The optical fiber shall be encapsulated in steel tube or armored during normal handling which shall be filled with jelly to provide high degree of protection from pressure and impact. Adequate free length of optical fiber shall be provided to offset longitudinal stress.
- b) Suitable material like high density polyethylene shall be used to protect optical fiber from abrasion. Optical Fiber shall be protected from water ingress and shall have adaptable 'ohmic' resistance. Splicing and preparation of optical fibers for termination shall be done with standard and approved/ certified equipment. All optical fiber cores coming shall be first terminated at fiber termination cabinet. Terminals and adapters used shall conform to the relevant specifications. Patch cable/ extension cable from the Splitter JB (first terminal box) to the terminal equipment (PLC cabinet, DCS cabinet etc.) shall be redundant, routed separately and adequately protected against physical damage/ fiber breaks. Each fiber within the cable shall be uniquely colored and tagged for identification.

Splice boxes (DIN Rail mounted), data connectors, patch cables, couplings, pigtailed etc. shall be Pheonix or equivalent make.



- c) The cable shall be chemical resistant, termite & rodent proof and moisture proof. It shall be flame retardant/ fire resistant depending on application as defined in FS-3508.
- d) Optical equipment e.g. Fiber Optic interface modules/ communication modules, standard connectors, switches, network components etc. shall be provided in a redundant configuration for end-to-end communication as per scope of work to ensure effective connectivity.
- e) Specific to topside or sub-sea requirement, following shall also be complied:

1. For topside use:

Optical Fiber cable laid between platforms in the same complex shall be multi-mode type. For further details, refer Instrumentation FS-3508 (Instrumentation Cables).

2. For sub-sea use:

- i) Optical fiber cable in composite cable shall have high strength, low loss and should be designed to meet both mechanical, optical

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requirement and shall be suitable for laying up to 100 meters of water depth.

- ii) The optical fiber cable shall be corrugated steel tape armored comprising of minimum of 12 Nos. single mode fibers. Number of fibers of each kind and their construction shall be selected so as not to load the individual fibers beyond 50% of their bandwidth capacity and 50% of the number of each type of fibers shall be available spare in the cable for future use.

For further details, refer Electrical FS-4020 (Subsea Composite Cable).

3.6.4.2 INSTRUMENT POWER SYSTEM PHILOSOPHY

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3.6.4.2.1 Pneumatic/ Hydraulic Supply

- a) For Pneumatic Instruments, dry instrument gas/ air supply shall be as per Clause 3.6.4.1.4.1 above.

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- b) Hydraulic power supply for hydraulic systems shall be as per the relevant Functional Specifications FS-3511, FS-3506 etc. as applicable.

3.6.4.2.2 Electric Power Supply

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- a) Components of power supply system shall be of the highest available quality for reliability and long service life.
- b) Contractor shall provide Uninterruptible Power Supply (UPS) for all field instruments, DCS, ESD system, F&G system, control room instrumentation etc.
- c) Power distribution to all instruments shall be through independent *indicating cartridge type* fuses for isolating the instruments during maintenance.
- d) Dual redundant power supply units shall be fed from different power distribution boards. Where dual redundant power supply in cards/ modules/ sub-systems is specified, the supply shall be fed from different power supply units.
- e) In general, the following Power Supplies shall be used:

1. For Process Platforms and Smart Wellhead Platforms with External Power through cable:

- i. 230/ 110 VAC \pm 5%, 50Hz \pm 1% (UPS with 'Maintenance free' Battery Back-up) for all Instrumentation & Control System(s) e.g. DCS, ESD System, F&G System, etc. However, the Instrumentation & Control System(s) using the UPS supply shall be suitable for 230/ 110 VAC \pm 10%, 50 Hz \pm 3%.
- ii. 24 VDC \pm 5% as applicable for field instruments, interrogation voltage (Logic/ Interlock systems), Solenoid valves, Detectors in Fire & Gas system, etc. This voltage may be derived from the '230/ 110

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- VAC' UPS voltage by the respective System Vendors in their system panels for use.
- iii. F&G system shall have floating ground power supply (with its '–ve' not earthed).
 - iv. Non-UPS power 230/ 110V AC \pm 5%, 50Hz \pm 1% for backlit level gauge illumination and panel interior lighting.
 - v. 230 VAC \pm 5%, 50Hz \pm 1% (Non-UPS Utility Power) for maintenance activities, miscellaneous requirements, Utility sockets, etc.
 - vi. Independent battery back-up shall be as per FS-3500.

2. For Conventional Wellhead Platforms:

- i. 24 VDC \pm 5% Battery Negative earthed for field instruments, solenoid valves, status lamps and Process PLC (if specified in SOW).
 - ii. 24 VDC \pm 5% for F&G System. F&G system shall have floating ground power supply (with its '–ve' not earthed).
 - iii. Independent battery back-up shall be as per FS-3500.
- f) Any other voltage levels required by Instrumentation Package Vendor shall be obtained/ converted from power supply mentioned at Clause e) above in respective panels itself and distributed within system battery limit.
- g) AC/ DC distribution board with Supply type (AC/ DC with rating) tag shall be provided with suitable isolator/ switches and fuse units for each feeder.
- h) For details of electric supply system, refer Electrical SOW and Electrical Design Criteria.

3.6.4.3 INSTRUMENT EARTHING SYSTEM PHILOSOPHY



Following Instrumentation items or equipment, but not limited to the list, shall require different types of Earthing:

- Field Instruments,
- Control System Cabinets,
- Analyzer Housing/ Cabinet,
- Junction Boxes,
- Enclosures,
- GI Cable Trays
- Consoles.


Mainly three separate Earthing Systems shall be provided for Instrumentation.

- a) **Electrical Safety Earth** – Bonded to the site structure and utilized for electrical safety of metal enclosures and chassis on all instruments and electrical components.


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Cable armors shall be earthed at both ends for lightning protection/ shock prevention i.e. at the Junction Box and at the Control System end. Since the Junction Box body and Control System cabinet body is connected to the site structure, cable armors are ultimately connected to the Electrical Safety Earth.




-  b) **Instrument Clean Earth** – The primary aim of the Instrument Clean Earth is to provide a low impedance path to the noise currents induced by RFI/ EMI. Shields of Single pair/ Multi pair Analog Instrument Signal Cables shall be connected to this Earth.

Instrument Cable Screens/ Shields shall be cut at field sensor/ instrument end and properly taped/ heat shrunk to insulate from the site structure and other metal works and bonded to the main electrical earthing system at a single point to avoid creation of grounding loops. It shall be properly terminated at Marshalling Cabinet side.

-  c) **Intrinsically Safe Earth** – This Earth shall be provided for IS instruments only and shall be utilized for termination of IS active barrier Earth connections. It shall be insulated from the site structure and other metal work and bonded to the main Electrical earthing System at a single point.

3.6.4.4 EQUIPMENT PROTECTION PHILOSOPHY

3.6.4.4.1 Environmental Protection

-  a) All instruments/ equipment and installation material shall be suitable for the overall climatic & ambient conditions and the local environment specified in the Basic Bid work. The conditions will include exposure to moist salt laden atmosphere, sea water splash, sunlight, monsoon rainfall, high ambient temperature and humidity, wind, fungal growth, vibration and shock, EMI and RFI. All equipment shall be capable to withstand these conditions during shipment, storage and installation prior to commissioning. Instrumentation shall withstand not only the quoted environmental conditions, but also the periodic testing of the Deluge or Fire Hose System.
- b) As all of the Company's sites are subject to seismic activity as indicated in the General Basic Bid Work and General Design Criteria, all instrument/ electrical frames, panel and racks shall be securely fixed in position.
-  c) In view of the highly corrosive ambient conditions, all internal and external parts which are not inherently corrosion resistant by choice of material shall be prepared and finished by plating or paint finish in accordance with FS-2005 (Structural Functional Specification for Protective Coating). Seals and purges shall be used as necessary, to ensure high resistance to corrosion and provide reliable instrument performance.
-  d) All field instruments shall be provided with necessary weather and anti-corrosion protection. All field instruments shall be provided with plastic bags (min. 1.5 mm thick) to protect them during handling, installation and commissioning. The bags shall be kept in place at all times except during

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work on the devices. Drying agent (desiccant) shall be put inside the bag and shall be replaced after its color change. Additional protection by other means such as canvas shall be provided to prevent damage caused by welding during construction work at nearby location. Labels and tags that may be exposed to paint spray shall be temporarily masked with a transparent material during construction activities, which shall be removed at the time of hand over of the work. Plastic plugs/ caps shall be fitted to all instrument tubing and air, process and cable entry ports until final connections are made.

- e) Corrosion allowance shall be considered in addition to the design thickness of all plates/ sheets and materials used for installation, hand-wheel of valves, weather hoods, mini shelters, stanchions, supports etc. to arrive at the minimum thickness requirement, as the same are exposed to harsh marine environment on the platform. Painting shall be done in line with the painting specifications enclosed in the bid document.



3.6.4.4.2 Ingress Protection

- a) All electronic field instruments shall have ingress protection to IP-65 or better. All pneumatic field instruments used in control applications shall have ingress protection to IP-55 or better. All instruments installed inside pressurized equipment/ control rooms shall have ingress protection to IP-42 as a minimum.
- b) Control Panels shall be suitable for Hazardous Area Classification. However, in general:
- Control Panels in open areas shall be IP-65 rated or higher.
 - Control Panels in non-pressurized equipment rooms and enclosed areas shall be IP-54 rated or higher.
 - Control Panels in pressurized equipment rooms and control rooms shall be IP-42 rated or higher.

3.6.4.4.3 Tropicalization

All electrical components shall be tropicalized to protect against humidity, moisture and fungal growth by means of hermetically sealed units, protective coating on circuit boards, gold plated edge connectors, etc.

3.6.4.4.4 Hazardous Area Instrumentation



- a) The Hazardous Area shall be classified in accordance with API RP 505 or API RP 500. All instruments which are mounted outside of normally pressurized control/ equipment rooms shall be certified by statutory bodies such as IEC/ FM/ UL/ BASEEFA/ CENELEC/ CSA/ PTB/ ATEX/ PESO for

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use in Class I, Div. 1, Group C & D, T3 Hazardous Area, *irrespective of instrument's location.*



b) "Intrinsically safe" protection shall be provided for all process transmitters in hazardous areas using external barriers.

c) All other instrument loops e.g. solenoid valves, gas detectors, UV, IR fire sensors, intercom/ paging system etc. shall be explosion proof/ flame proof conforming to Ex-d or NEMA-7.



d) Where instruments are not manufactured with enclosures suitable and certified for Class I, Div. 1, Group C & D or Class I, Zone 1, Group IIA and IIB, enclosures suitable and certified for Class I, Div. 2 Group C & D or Class I, Zone 2, Group IIA and IIB may be accepted for installation in areas classified as 'Class I, Div.2 Group C & D or Class I, Zone 2, Group IIA and IIB'.

However, instruments certified for use in Class I, Div. 2, Group C & D or Class I, Zone 2, Group IIA and IIB areas shall not be installed in areas classified as 'Class I, Div.1, Group C & D or Class I, Zone 1, Group IIA and IIB'.

e) Local Indicator, Transmitter, Input/ Output to peripheral devices like laptop computers & networks etc. shall be intrinsically safe.

f) All 'enclosure type' shall be certified by statutory bodies like IEC/ FM/ UL/ BASEEFA/ CENELEC/ CSA/ PTB/ ATEX/ PESO etc. for use in the area applicable.

g) Intrinsic safety approval shall be based on entity concept and necessary compatibility checks shall be carried out by Contractor before selecting any loop component. Isolating barriers shall be normally active type unless otherwise specified. It shall be plug-in type, mounted on modular back plane termination units. Each individual input and output in a loop shall have its separate barrier. No barrier shall be shared between any two loops.



3.6.4.4.5 Radio Frequency (RF) and Electromagnetic (EM) Interferences

All equipment shall remain unaffected and immune to RF-EM interference as per IEC 61000-4-3. Levels of permissible RFI and EMI shall be as per IEC 61000-4-3. Band-pass and/ or band stop filters shall be fitted, as necessary.



3.6.4.4.6 Sealing

a) Seal systems shall be used to isolate instrument from the process fluid encountered in the following services:

- Process fluids that vaporize, condense or solidify under operating pressure and ambient temperature.
- Process fluids that will subject the sensor to high temperature.

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- Corrosive process conditions.
- Viscous liquids.

b) Sealing may be accomplished with diaphragm seals.

c) Any other protection, if required, shall also be provided.

3.6.4.5 MATERIAL SELECTION PHILOSOPHY



a) All materials and equipment furnished shall be new and unused, free of defects, highest grade & quality and in current manufacturing range for the required service.

b) Material of Construction (MOC) of instruments shall be chosen as per temperature, pressure, corrosion conditions and other process requirements.

c) Suitability of material for the corrosive effects of the harsh offshore atmosphere.



d) Suitability of wetted parts for the specified process conditions, with SS-316 as a minimum, for outside pressurized rooms and Monel for salt water service. SS316 shall be with carbon content of 0.08% or better to improve resistance to corrosion.

e) Galvanic compatibility between dissimilar materials, with isolating bushes, plates, used where necessary to prevent corrosion due to galvanic action.



f) Wherever process condition demands NACE quality Instrument tubing and fittings, the same shall be provided as per latest NACE standard material. For non-NACE application, material for tubing and fitting shall be appropriate for relevant process fluid with SS-316 as minimum.

g) MOC of Instrument Enclosures and Junction Boxes (JB) shall be SS-316/ epoxy coated copper free (i.e. less than 0.4% copper by mass) die-cast Aluminum.

h) Moulded polyester parts shall be Anti-Static for Hazardous Area locations, and in general, be constructed from UV-stabilized glass reinforced polyester. Impact Resistance shall be in accordance with IEC-62262 & IEC-60068-2-75.

i) All proposed Vendor standard plastic components, if any, shall be non-toxic and fire resistant, UV stabilized and compatible with the environmental conditions.

j) All spindles, bushings, bolting, screws, brackets, etc. shall be manufactured from a suitable grade of stainless steel as minimum. All bolts and screws shall have a flat SS-316 washer under the nut, and the thread length shall be such that there is complete full engagement of the nut, with a minimum of two threads protruding.

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k) Supports for instruments and any other item directly welded to the structure shall be painted conforming to latest revision of Functional Specification FS-2005 (Structural FS for Protective Coating).

l) All wetted parts of instruments which are in contact with process fluid containing CO₂ in excess of 2 PSI partial pressure shall be as follows:

Fluid Temperature	Material to be used
<71°C	ASTM A182-F316 (316SS)
>71°C	ASTM A182-F51 (2205 duplex steel)

m) The MOC for the wetted parts and the body of all individual instruments shall be as per the Material Selection Chart wherever given in the Annexure of the relevant Functional Specification. The MOC of all parts shall be as indicated in Material Selection Chart or better suitable for the process conditions.

Where such chart is not available/ piping class is not covered in the respective FS, Vendor shall follow material specified in PMS and/ or P&ID and suitable for the fluid composition and the process conditions. Proposed MOC shall be subject to Company's review and approval.

n) The details of various piping classes mentioned in these Material Selection Charts shall be as per Piping Material Specifications (PMS) enclosed with the 'Piping' section of the bid document.

3.6.4.6 INSTRUMENT INSTALLATION PHILOSOPHY

a) All work shall be of the highest quality craftsmanship and shall conform to the best applicable engineering practices and relevant codes referred in the bid document. Installation of field mounted instruments for process measurement in general shall be in accordance with API RP 551.

b) All instruments and accessories shall be installed in a neat workman like manner for ease of operation and maintenance.

c) The Contractor shall prepare hook-up and installation detail drawings for each type of instruments, junction boxes, control panels etc. Installation shall be carried out in accordance with approved drawings.

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d) The Contractor shall install instruments and equipment with due consideration to the following:

i. All process instruments shall be located as close as possible to the point of measurement and accessible from the deck, ladder or a platform.

ii. Instruments shall be mounted/ connected so as not to stress vessel nozzles or pipe tapping.

iii. Instruments e.g. PT, DPT, FT etc. shall not be installed by taking support of its impulse piping/ tubing or electrical connections. Pressure gauges and Temperature indicators shall be installed directly on process piping.

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- iv. All cables/ tubing shall be properly laid on cable/ tube trays which shall be supported at regular intervals. Instruments, tubing, cables and cable ladder shall not be fixed to gratings or handrails unless approved by the Company.
 - v. Fittings such as instrument isolating valves and instrument air or gas regulators shall be supported either on the stanchion or close-coupled to the instrument in a manner that no undue stress is imposed on the tubing or instrument.
 - vi. Visibility and accessibility shall be ensured for maintenance and operations purpose.
 - vii. Positioning of equipment/ instruments shall not constitute a safety or operational hazard.
 - viii. Wherever possible, instruments and junction boxes shall be installed such that they are protected from the effects of rain and sun, ensuring easy access and visibility. Where this is not possible, a fixed cover or hood shall be provided to protect instruments, without impairing access or visibility.
 - ix. All the instruments and detectors in the well bay area shall be protected by fixed cover or hood.
 - x. Field mounted Local Control Panels shall also be weather protected by minimum 3mm thick stainless steel canopy.
 - xi. All instruments shall be installed and fastened such that deck vibration does not affect their performance.
 - xii. Easy access and provision for lifting heavy items e.g. valves, pressure relief valves, orifice etc. shall be provided.
 - xiii. Instruments requiring frequent routine access (including hand-valves, manual resets, manual switches, etc.) shall be mounted approximately 1.4m above the Top of Plating (TOP)/ Top of Grating (TOG) for ease of accessibility
 - xiv. Instruments shall be properly supported on brackets or mounted on sub-plates, or placed on a suitable pedestal, pipe stand or structural support. Pipe or structural stands may be welded directly onto platform plate, with a suitable penetration in the grating, where applicable. Where platform's structural member is used for the mounting of instruments/ accessories, the same shall be done at yard before the painting/ finishing of the structural member so that welding at offshore site should not make it susceptible to corrosion in marine environment.
- e) Instrument stanchions, gauge boards, junction boxes and panels shall be mounted as per approved drawings and with consideration for:
- i. The most direct routes for tubing and piping to and from the above mounting arrangements, using common tubing runs and avoiding crossovers.

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- ii. Ease of inter-connections between instruments.
- iii. Ease of access for on-site calibration and/ or removal of instruments
- iv. Minimum interference between tubing, piping and cabling to instruments.
- f) SS-316 filter regulator with gauge shall be provided with each instrument requiring regulated gas or air supply.



g) The Contractor shall install drain and vent connections with due consideration to the following:

- i. All liquid drains of field instruments, especially for level instruments, shall be taken to the deck level facing downwards and routed to the nearest process/ deck drain.
- ii. All vents shall be suitably routed to safe location away from the operator/ maintenance personnel operating on the instrument. All atmospheric vent ports of venting instruments and pilot valves shall be fitted with bug screens.
- iii. All instrument drains/ vents not routed to deck drains/ safe locations shall be suitably plugged.
- iv. All vent/ drains on high pressure applications shall have seal welded connections and shall be tested suitably.
- h) The instrument mounting details (on stanchions/ deck plate, gratings, structural member etc.) shall be as per the standard engineering practices and installation standards, and the same shall be submitted for information with all necessary details of location and mounting.
- i) Working platforms with access ladders shall be provided for elevated inaccessible instruments.
- j) Wherever Piping or Vessel is insulated, electrical heat tracing shall be provided for Level Instruments too to avoid oil congealing or condensate formation.
- k) Additional installation requirements of individual instruments, if any, shall be as per the relevant Functional Specifications.



l) Stand Pipe/ Bridle Philosophy for Level Instruments

Stand pipes/ bridles shall normally be avoided. They can be considered only in small sized vessels/ boots having space constraint for nozzle tapping.

- i. In general, level instruments for alarm and trips should be mounted on separate stand pipes.
- ii. The material and rating of the nozzle isolation valves and pipe fittings shall match with the pipe specification of the vessel. The pipe diameter of the bridle should be minimum 2" NB.
- iii. Thermal insulation and heat tracing for standpipes/ bridles, sensor cages/ chambers shall be provided as per the associated piping
- iv. Standpipe shall not be used for Emulsions and induced emulsions formed

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- by foams agitation in highly agitated liquids.
- v. No level instrument shall be installed inside the standpipe itself.
 - vi. Standpipe connection from the bottom of the vessel shall be avoided.
 - vii. On horizontal vessels having boot, separate standpipe shall be used for boot interface level measurement in addition to standpipe for the horizontal vessel.
 - viii. Each instrument shall have its own isolation valves, vents and drain to facilitate maintenance. Lock Open (LO) isolation valves shall also be provided between the vessel and bridle. The distance between the standpipe and the vessel nozzle should not exceed 1.5 m.
 - ix. A vent valve shall be provided on top of standpipe to vent any air or gas in upper dead part of the standpipe. Minimum ¾" drain valve shall also be provided at the bottom.
 - x. Level instruments shall be mounted on bridle in such a way that no gas trap or liquid trap should occur when level in the vessel crosses the tapping level.
 - xi. Suitable strain relief measures e.g. bridle supports shall be provided to avoid unacceptable loads on the vessel nozzles due to long bridles, thermal expansion or heavy instruments mounting.
 - xii. Standpipes shall be fabricated as per level sketches.

3.6.4.7 INSTRUMENT INSPECTION & TESTING PHILOSOPHY

3.6.4.7.1 General



- a) The Vendor's quality plan shall include a comprehensive fully documented Inspection and Testing Plan (ITP) specific to the project.
- b) The Contractor/ Vendor shall consider all the testing requirements as mentioned in the individual IRTs for each type of instrument.
- c) The procedures shall include inspection specifically for compliance with hazardous areas requirements, including valid certificates, without which no circuit or loop shall be energized.
- d) Company Representative/ ONGC Certification Agency (CA) TPI shall check instruments, control panels and instrumentation-packages prior to shipment for compliance of Functional Specifications and Inspection Requirement Tables (IRTs).
- e) All testing, calibration and pre-commissioning shall be done by the Contractor. The Contractor shall also provide assistance as required during commissioning activities.

For major package equipment e.g. DCS, ESD System, F&G System, HIPPS etc. the Contractor shall carry out site testing, pre-commissioning and commissioning activities in the supervision of OEM/ Packager.

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- f) The Contractor shall provide suitable workshop facilities and shall provide all necessary test and calibration instruments and equipment.
- g) The Company reserves the right to reject any or all test and calibration work if found not complying with the specifications. The Contractor shall complete and submit documentation for all calibration, testing and pre-commissioning.
- h) The Contractor shall in the presence of the Company Representative/ ONGC CA TPI, verify by inspection, calibration and loop testing that all instrumentation in field and control room including local and remote control panels are complete and operable as per specification requirement. All testing and calibration shall be subject to approval by the Company Representative/ ONGC CA/ TPI.
- i) In addition to calibration/ testing, loop checking, setting for safety devices like process switches, safety valves etc. and simulation testing of all interlock and shutdown systems, done at fabrication yards, the same shall also be carried out at offshore site as well.
- j) Major Equipment e.g. DCS, ESD System, F&G System and HIPPS shall be inspected during Factory Acceptance Test (FAT) based on the approved FAT document. Site Acceptance Test (SAT) shall be done at site during commissioning as per approved SAT document.
- k) Logic as per approved Cause & Effect Matrix, Safe Chart, Schematics etc. shall be demonstrated and checked by simulation during FAT. Changes in graphics, if any, shall be made based on user-feedback during FAT/ SAT.
- l) In general, the pipes and tubes shall be cleaned before testing. They shall then be subject to hydro-test (or other applicable tests) and then blow dried.

3.6.4.7.2 Flushing of Lines

The Contractor shall remove in line instruments like flow meter, control valves/ safety valves, if necessary, and provide spool pieces/ flanges prior to flushing of lines.

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3.6.4.7.3 Instrument Air/ Gas Supply Lines

- a) Instrument air/ gas piping and tubing shall be disconnected upstream of all air filter regulators before testing and then piping and tubing shall be hydro tested. Then it shall be blown down to remove hydro test water, slag and mill scale.
- b) Instrument air/ gas supply lines shall be blown with instrument air prior to connecting to instruments. Instrument air/ gas mains shall be isolated from the instrument and pressurized to 1.5 times maximum working pressure with instrument air, they shall be isolated from the pressure source and the pressure reading on test gauge shall not fall by more than one psig in ten minutes.

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- c) Nitrogen shall be used at wellhead platforms where Instrument Air is not available.



3.6.4.7.4 Instrument Signal Lines

- a) Instrument signal lines shall be blown with instrument air/ gas prior to connecting to instruments.
- b) Nitrogen shall be used at wellhead platforms where Instrument Air is not available.
- c) All air/ gas tubing shall be tested and inspected by one of the methods given in ISA RP 7.1 “Pneumatic Control Circuit Pressure test”.

3.6.4.7.5 Impulse Lines

- a) All process impulse lines shall be disconnected and flushed with potable water. Air lines shall be blown down with filtered air. Hydraulic lines shall be flushed with hydraulic oil.
- b) After flushing, process impulse lines shall be isolated from the instrument and pressurized hydraulically to 1.5 times maximum working pressure corrected for ambient temperature. They shall then be isolated from the pressure source and the pressure reading on a test gauge shall not fall at a rate exceeding one psig/ hour.



3.6.4.7.6 Direct Mounted Level Instruments

For the direct mounted level instruments, the associated equipment/ vessels/ tanks shall be pressurized to the maximum operating pressure gradually and steadily with the instrument on line. The equipment/ vessels/ tanks shall then be isolated from main pressure source. The pressure shall not fall at a rate exceeding one psig/ hr.

3.6.4.7.7 Wiring

- a) Wiring shall be checked to ensure that it is correctly connected and properly grounded. Insulation test shall be carried out on all wiring taking necessary precautions. Correct connections of all switches shall be checked.
- b) Tests for Cables and wiring shall be as per the specifications elaborated in the Electrical section of the bid document. Wiring shall be ‘Megger’ tested as a minimum for the rated voltage.

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3.6.4.7.8 Calibration & Testing

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- a) During pre-commissioning/ commissioning, the Calibration/ Testing of instruments shall be done with the instrument or system in place, wherever possible. Otherwise instrument calibration shall be done prior to installation.
- b) All analog instruments shall be calibrated in both upscale and downscale directions. Five (5) Point calibration shall be done at 0, 25, 50, 75 and 100 per cent of the instrument range upscale (rising) and 100, 75, 50, 25 and 0 percent of the instrument range downscale (falling). Upon completion of these tests, the instruments shall be drained, the components removed and the shipping stops put in place.

5 point recalibration shall also be checked during pre-commissioning/ commissioning.
- c) Factory calibrated flow meters shall be installed and fastened as per Vendor guidelines after the associated piping has been flushed and blow dried.
- d) During pre-commissioning/ commissioning, all Control Valves prior to stroke checking shall be cleaned thoroughly. The full stroke of valve shall be checked for opening and closing in the range of 0%, 25%, 50%, 75% and 100% (rising & falling).
- e) Pressure safety valves shall be set/ tested by using dry air/ nitrogen for gas service and water for liquid service.
- f) All trip switches shall be calibrated over the entire range and checked for set points & reset points as per the alarm & trip schedule.
- g) Solenoid valves shall be checked functionally for its operation, auto/manual reset and seat leakages.
- h) If Process SOW or P&IDs mention Partial Stroke Testing (PST) of Shutdown Valves (SDV), PST check shall be demonstrated during FAT/ SAT.
- i) Tight Shut Off (TSO) Control Valves and Shut Down Valves shall be checked for seat leak test and gland leak test.
- j) All special instruments like analyzer shall be checked and calibrated as per manufacturer's instruction. Prior to testing, all analyzer sample lines shall be thoroughly cleaned by Carbon Tetrachloride or any other cleaning liquid. After cleaning, these lines shall be thoroughly purged with dry nitrogen.
- k) **Testing and Calibration Report**
 - i. The Contractor shall provide records of all instrument calibration/ testing in prescribed format (Annexure-I).
 - ii. Calibration Certificates of all Master calibration equipment used for site calibrations like pressure gauges, HART calibrator, multifunction calibrator, multimeter etc. shall be traceable to PTB (Physikalisch-Technische Bundesanstalt)/ NMI (Netherlands Measurement Institute, National Metrology Institute, National Measurement Institute)/ OIML

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(Organisation of Legal Metrology)/ NEL (National Engineering Laboratory)/ NABL (National Accreditation Board for Testing & Calibration Laboratories) etc. accredited laboratories certified in accordance with ISO/ IEC 17025 (General requirements for the competence of testing and calibration laboratories) standard.

The Contractor shall submit these documents along with Annexure-I.

3.6.4.8 INSTRUMENT SPARES PHILOSOPHY

3.6.4.8.1 For all major equipment, the Contractor shall include Commissioning Spares (Annexure - VI) and Mandatory Spares in the Purchase Specification (PS) as a part of the supplied package/ system/ instrument.

The Contractor shall also furnish list of recommended spares for one year's trouble free operation in prescribed format (Annexure - VII) along with the prices for Company's review.

3.6.4.8.2 Original Equipment Manufacturer (OEM)/ Packager shall provide guarantee for supply of spares for at least 10 years for electronic instrumentation system(s) for the entire life cycle of the item.

In case, Vendor intends to phase out the models of the supplied major systems such as DCS/ PLC/ F&G System etc. any time after 07 years, they shall intimate the Company well in advance and ensure availability of spares for supplied systems for the next 03 years.

If the Vendor intends to phase out the model of the supplied system before 07 years have elapsed, they shall intimate the Company well in advance and ensure availability of spares for the balance period of 07 years and an additional 03 years.

3.6.4.8.3 All spare parts shall comply with the same standards and specifications as the original equipment/ system and shall be fully interchangeable with original parts.

3.6.4.8.4 All spare parts shall be marked with the manufacturer's part number and description.

3.6.4.8.5 All spare parts shall be packed separately from the main equipment/ system/ instrument and shall be properly protected to prevent deterioration and damage during shipment and storage.

3.6.4.8.6 The spares requirement of individual systems shall be as per the relevant Functional Specifications enclosed elsewhere in the bid document. However, unless otherwise mentioned, the following shall be the basis for finalizing the minimum requirements of spares for instrumentation:

a) Mandatory spare instruments shall be 10% minimum or 1 (one), whichever is higher, of each type and range for PG, DPG, TG, T/C, SOV, RTD, AFR & I/P Convertor/ Smart Positioner. It does not include PSV, CV, field transmitters, field switches, flow meters and LG.

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The above is applicable for both field instruments and instrumentation/mechanical/ electrical packaged equipment.

The mandatory spare instruments shall be supplied for each Platform under New as well as Modification scope.

- b) It is Vendor's responsibility to have commissioning spares as required for commissioning of plant and shall be included in their firm scope of supplies/work.
- c) For control panels, installed spares shall be 20% minimum or 1 (one), whichever is higher, for Indicating Lamps, Annunciation Windows, Selector Switches, Push Buttons, Relays, Power Feeders (AC & DC) (in ACDB & DCDB), Switch Fuse units (for loop power supply). These spares shall be wired up to the terminal blocks (TB) in the system and marshalling cabinets.
- d) Loose spares for panels shall be 5% minimum or 1 (one), whichever is higher. Items to be considered as loose spares are indicating lamps, selector switches, push buttons, relays, MCBs, fuse and non-fuse type field TBs, Push-Pull Valves, Logic valves of each type, timers etc.

Same is applicable for packaged equipment.

- e) For Wellhead Shutdown Panel, minimum 1 No. Well Control Module & Minimum 1 No. Test Separator Shutdown Module shall be provided or as specified in scope of work.
- f) Installed I/O Card modules shall be 20% minimum or 1 (one), whichever is higher, for card based F&G systems.
- g) Control panels shall have additional 20% free space available for future expansion.
- h) For well head panels, 10% spare instrument air header branch lines and 15% spare bulk heads (for each size) shall be provided in each panel.
- i) In junction boxes (JB), 20% wired spare terminals shall be kept as installed spares.

Also, while choosing multi-core/ multi pair cables, minimum, 20% cores/pairs shall be kept as spare for future use. The entire cable shall be terminated at both ends (JB and Panel) including spare cores/ pairs. Spare cable entries shall be plugged/ blinded.

- j) For cable tray sizing, cable tray width shall be sized so that 50% space is free and available for future use.
- k) Consumable spares for a minimum of 06 months duration after commissioning which shall include printer paper, toner cartridges etc. shall be provided.

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3.6.4.9 PHILOSOPHY FOR FUTURE FACILITIES

Provisions to operate, monitor, control and shutdown shall be made in all control systems such as control panels (system and marshalling) and shutdown panels

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etc. for future facilities, wherever shown in P&ID and/ or indicated in the Basic Bid Work. All panel/ cabinet mounted instruments and accessories required for this purpose shall be supplied and installed by Contractor.

3.6.5 INSTRUMENT PROCESS CONNECTIONS

a) Process connections for instruments on vessels/ stand-pipes/ piping/ tanks/ equipment etc. shall be as per Annexure - XVI.

b) First isolation/ block valve in piping scope and impulse piping (if used) of all instruments shall be as per the piping specifications and shall meet the line or vessel specification.

The first block valve shall be installed as close as possible to the process tapping. Unions between the process tapping and the first block valve are not permitted.

c) Instrument isolation valves and manifolds shall be provided as per hook-up drawings. Vent and drain valves shall be provided in the vent tubing/ piping and drain.



d) Tap-offs from lines or vessels for all direct connected pressure instruments shall meet the line or vessel specification. After individual piping block valve, all Pressure instruments shall have 2-valve manifold and Differential Pressure instruments & Multivariable Transmitters (MVT) shall have 5-valve manifold.

For DP level instruments, the manifold arrangement shall be such that the filled leg and dry leg are not equalized during isolation and bleeding of the legs.

e) A maximum of 02 (two) pressure instruments may be connected to the same pressure tapping, if their function is not safety-related. Instruments for ESD systems shall each have their own individual tappings.

f) For Thermowell installation, minimum piping size shall be 4". For line size below 4", expander-reducer can be used. Flange connection and electrical connections shall be as per respective functional specifications.

g) Tubing and fittings for air/ gas supply, transmission and control signals, and process impulse lines shall be as per FS-3507 (Instrumentation Bulk Materials). Threaded end connections shall be as per ANSI B 2.1.

h) Flanged connections shall be as per ANSI B 16.5. The Contractor shall provide suitably rated flange adaptors to allow tubing connections where required.

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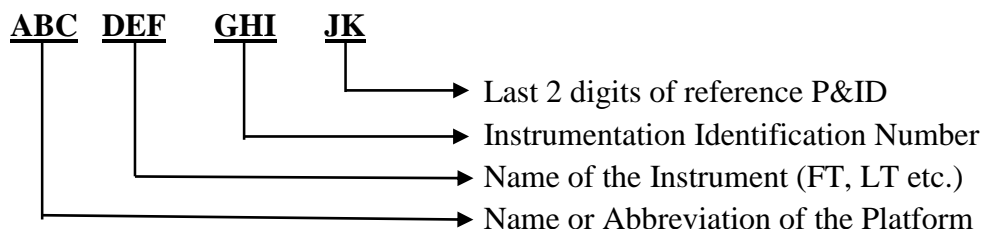
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3.6.6 GENERAL REQUIREMENTS

3.6.6.1 TAGGING AND NAME PLATES



- a) The Contractor shall assign individual tag numbers in accordance with the Company's established system to all instruments. The tag numbers shall in general be as follows:



Fire & Gas devices shall be tag numbered as specified in FS-3500.

- b) The tag number of every instrument shall appear on all relevant drawings and documents that pertain to the specific instrument.
- c) Nameplates and identification tags shall be provided to properly identify each piece of instrumentation/ equipment including instruments, Junction boxes, bulkhead connections, cables, wiring etc.
- d) All instruments shall have SS tag or nameplate of a permanent type with identification number and service description.
- e) All panel name plates shall be made of Stainless Steel or Traffolyte with black engraved lettering on white background.
 The name plates shall be fastened with SS 316 screws/ riveted.
- f) Name plates of front mounted panel instruments e.g. Flow computer shall be made of Traffolyte with black engraved lettering on white background. Also, name plates shall be provided inside the panel on the rear of instruments for clear identification.



- g) All wiring, cables, tubing, junction boxes etc. shall be properly tagged. Plastic adhesive tapes shall not be used.
 All wiring shall be tagged with ferrules at both ends.
 All tubings and cables tag plates shall be of SS316 and properly binded with SS316 wire.
- h) Labels shall be positioned directly on the equipment or immediately adjacent for best visibility.
- i) Typical instrument label details for sour service shall be as per Annexure – III.

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3.6.6.2 DOCUMENTATION

The Contractor shall provide final documentation in hard copies and electronic form as per the Volume-I of the Bid.

All the AS-BUILT documents shall be verified by ONGC CA/ TPI and duly signed by LSTK Contractor and their DEC.

3.6.6.2.1 Project Documentation

- a) Design Engineering Consultant (DEC) shall prepare the Project DCI/ MCI along with its category (Approval/ Information) in line with the project scope of work and Standard DCI/ MCI (Appendix C8 of Bid), including any additional documents, and obtain approval from Company.
- b) The Contractor shall be responsible for the authenticity of the Vendor/ Sub-Vendor drawings and data.
- c) Detailed test schedules for FAT & SAT shall be submitted for Company's approval one month before the testing for major packaged equipment like DCS, ESD System, F&G System, HIPPS etc. For details refer respective FS.
- d) Any additional data/ drawings required during detailed engineering shall be furnished by Vendor/ Contractor.
- e) All drawings and literatures shall be in English language and in the Metric Measurement System.

3.6.6.2.2 Instrument Index

The Contractor shall provide Instrument Index. The index shall include the following information, as applicable:

1. Instrument Tag Number
2. Instrument type/ description
3. Service Description
4. Process Fluid
5. P&ID No./ F&G Detector Layout No.
6. Location of instrument (Field, Control Panel etc.)
7. Vessel/ Line/ Equipment details
8. Operating Pressure/ Temperature/ Flow/ Level parameters
9. Signal (Analog/ Digital/ Serial)
10. Type of Signal (IS/ NIS)
11. Manufacturer/ Model
12. Instrument Range
13. Calibrated Range
14. Purchase Specification No.
15. Data Sheet Number
16. Hookup Drawing No.
17. Installation Drawing No.

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18. Remarks

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3.6.6.2.3 Purchase Specification (PS)/ MCI

Purchase Specifications (PS) shall be submitted for Company's review/ approval.

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3.6.6.2.3.1 Deliverables

PS shall have the following documents (as applicable). The PS shall be indexed with page numbers and duly endorsed by LSTK Contractor, DEC and Vendor:

1. Cover sheet mentioning the document number and Vendor details
2. Form-A - Technical Questionnaire (Annexure-IV)
3. Form-B - Compliance to Bid Specifications (Annexure-V)
4. Form-C - List of Commissioning Spares (Annexure-VI)
5. Form-D - List of One year Operational Spares (Annexure-VII)
6. Form-E - List of Special Tools & Tackles (Annexure-VIII)
7. Form-F - List of Construction Spares & Consumables (Annexure-IX)
8. Form-G - Vendor Weight Control Datasheet (Annexure-X)
9. Form-H - Equipment Weight Certificate (Annexure-XI)
10. Form-I - Vendor DCI/ MCI or Vendor Data Schedule (Annexure-XII)
11. Form-J - Vendor Document Review (Annexure-XIII)
12. Form-K - Utility Requirement (Annexure-XIV)
13. Responsibility/ Work Scope Matrix showing responsibilities of LSTK Contractor, DEC and Vendor (Annexure-XV)
14. Instrumentation Design Criteria, related Functional Specifications and IRTs etc. duly signed and stamped by the Vendor.
15. Vendor's Quality Assurance Plan/ Inspection Test Plan approved by ONGC CA/ TPI in line with IRT.
16. Process Datasheets
17. Instrument Datasheets, Specifications and Model De-codification
18. Sizing calculations
19. Job Specification
20. Hardware & Software Functional Design Specification
21. System and Network Architecture
22. Bill of Material
23. General Arrangement Drawing
24. Internal Arrangement Drawing for Panels
25. Power wiring diagram
26. Cable termination drawing for panels
27. Wiring diagram
28. IO Allocation
29. Controller Loading Calculations
30. Power Consumption Calculations
31. Heat Load Calculations
32. Instrument air/ gas consumption details

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33. Grounding details
34. Panel wiring table list
35. Reliability/ PFD calculations
36. Loop wiring diagrams
37. Loop schematics
38. Functional schematic & Logic Diagrams (as applicable)
39. Catalogues
40. Installation, Operation and Maintenance Manual (IOM)
41. Weather protection, hazardous area classification & SIL certificates
42. Test certificates, as applicable

3.6.6.2.3.2 Instrument Data Sheet

Contractor shall submit Instrument Datasheets endorsed by Vendor and approved by DEC in Purchase Specifications.

- a) The datasheet shall be as per the formats specified in respective Functional Specifications (FS).
- b) Where datasheets are not provided in the respective FS, the datasheets shall be in accordance with relevant ISA standards.
- c) When a number of instruments are identical in their requirements, they can have a common datasheet with all the associated tag numbers annexed with the datasheet.

3.6.6.2.3.3 Instrument Sizing Calculations

The following Sizing Calculations endorsed by Vendor and approved by DEC shall be submitted in Purchase Specifications:

1. Control valve sizing
2. Flow Meter sizing
3. SAPCV sizing
4. Pressure Safety Valve (PSV) and Temperature Safety Valve (TSV) sizing
5. Shutdown/ Blowdown valve torque calculation and stroking time
6. Thermowell Wake Frequency
7. Restriction orifice (RO) sizing
8. Hydraulic Design Calculations including reservoir & accumulator sizing

3.6.6.2.3.4 Manufacturing Record Book (MRB)

In addition to PS deliverables mentioned in Clause 3.6.6.2.3.1 above, following documents as a minimum shall also be included in Manufacturing Record Book (MRB) as a part of AS-BUILT documentation:

1. Instrument calibration procedures
2. Proposed maintenance schedule of all major components, for the design life of the system, and their replacement requirements
3. Calibration reports and Loop checking reports

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4. Test Certificates
5. Material Take Off

3.6.6.3 REVIEW AND APPROVAL

3.6.6.3.1 The Contractor and Design Engineering Consultant (DEC) shall review, scrutinize and approve all Vendor & Sub-Vendor documentation submitted as part of detailed engineering for all instruments, instrumentation packages, control systems etc.

Only DEC approved drawings and documents shall be submitted for Company's review.

3.6.6.3.2 For other details of review and approval processes, refer General Conditions of Contract (GCC) of Bid Volume-I.

3.6.6.4 VENDOR SELECTION AND PRE-QUALIFICATION

3.6.6.4.1 Selection of Instruments/ Control Systems

All instruments/ control systems offered shall be of proven design and in current manufacturing range.


3.6.6.4.2 Selection of Vendors

- a) Contractor shall select Vendors from the Suggested Vendors List (SVL) of OES.
- b) Existence of the Vendor's name in the suggested vendor list does not absolve the Contractor from supplying equipment of proven design as per the Company specification.

3.6.6.4.3 New proposed Vendors/ Pre-Qualification of new Vendors

- a) Where the Vendor is not listed in SVL, Contractor shall follow provisions of Bid Volume-I. Contractor shall request acceptance of such new Vendor with proper justification.
- b) Contractor shall submit Pre-Qualification Documents (PQD) comprising of Vendor Checklist and documentation for such acceptance.
- c) The Contractor shall not place PO to new Vendor prior to acceptance by Company.

3.6.6.5 PACKAGING & FORWARDING/ SHIPMENT/ TRANSPORTATION

-  a) Instruments or parts, which can be damaged during shipment, shall be packed separately in the original manufacturer's boxes. Each crate, bag, box, pallet

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or package shall be identified with Purchase Order Number and Packing List in a weather proof envelope.

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b) Open ports or connections shall be properly sealed. Threaded connections shall be protected with forged steel or moulded threaded plugs/ caps.

c) All flanged openings shall be protected with wood or steel closures attached by proper bolting and sealed with a plastic compound to protect it from entry of foreign material and to protect the flange faces.

d) All mechanical or machined surfaces subject to atmospheric corrosion prior to installation on site shall be treated with an easily removable rust preventive coating.

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e) A desiccant shall be provided inside all box enclosures to prevent moisture damage due to high humidity.

f) A suitable desiccant shall also be placed inside those control panels or junction boxes, which contain electronic or electrical components during shipment.

g) Any equipment or its component exceeding 15 kg shall be supplied with lifting lugs or eye bolts. The lugs or eyebolts should be positioned such that the component can be readily slung from a point over its center of gravity.

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h) All items shall be properly packed, made sea worthy and protected from damage during shipment. Any instrument which could possibly be damaged during shipment shall be disassembled and removed. The disassembled instruments shall be packed and shipped with the associated system/ package. All openings shall be suitably sealed.

It is Contractor's responsibility to reassemble the disassembled instruments during installation of system/ package.

i) The electronic and electrical components removed from package-mounted panel shall be shipped independently. The shipping notice shall be written on the box or crate with red letters such as "Handle with Care"/ "Keep Dry"/ "Fragile" etc.

j) The Contractor shall be solely responsible for the adequacy of the Preparation for shipment. Contractor shall also state recommendations for long term storage (up to 12 months) for both indoors and open air storage.

k) Nucleonic/ Radioactive material handling:

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i. Packing, transport, replacement and disposal of nucleonic materials shall be the responsibility of Vendor and Contractor.

ii. Vendor and Contractor shall comply with the safety norms as per international standards & safety regulations and Bhabha Atomic Research Center (BARC, India) guidelines.

iii. Certification from Regulating Authority for safe exposure limit for human safety and operation of the 'nucleonic source' shall be furnished.

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iv. Vendor shall furnish all procedures for safe packing, handling and storage along with proper tools and SOPs/ instructions.



v. Procedure for safe disposal of radioactive material and its container shall be approved by statutory body of country of origin as well as by statutory body in India.



3.6.6.6 RECEIPT AND STORAGE

- a) The Contactor shall develop a comprehensive plan for receipt, storage and release of all equipment, instruments etc. including items supplied by Company or other Contractors/ Sub-Contractors. This plan shall provide the status and location of any item under its custody.
- b) The Contractor shall be fully responsible for equipment, instruments etc. under its custody. The Contractor shall provide safe and secure facilities to provide a storage environment which shall protect the equipment, instruments etc. as per Vendor's requirements. Any equipment, instruments etc. damaged under the custody of Contractor shall be repaired, reinstated or replaced by them.



3.6.7 ANNEXURES

Following annexures are *typical formats* which shall be submitted during design and execution stage.

1. ANNEXURE - I : Test And Calibration Form
2. ANNEXURE - II : Pneumatic Instruments – Air Supply Branching Connections
3. ANNEXURE - III : Label Details For Instruments/ Systems Handling H₂S
4. ANNEXURE - IV: FORM -A - Technical Questionnaire
5. ANNEXURE - V : FORM-B - Compliance To Bid Specifications
6. ANNEXURE - VI : FORM-C – List Of Commissioning Spares
7. ANNEXURE - VII : FORM-D – List Of One Year Operational Spares
8. ANNEXURE - VIII: FORM-E - List of Special Tools & Tackles
9. ANNEXURE - IX: FORM-F - List of Construction Spares & Consumables
10. ANNEXURE - X: FORM-G - Vendor Weight Control Datasheet
11. ANNEXURE - XI: FORM-H - Equipment Weight Certificate
12. ANNEXURE - XII: FORM-I - Vendor DCI/ MCI or Vendor Data Schedule
13. ANNEXURE - XIII: FORM-J - Vendor Document Review
14. ANNEXURE - XIV: FORM-K - Utility Requirement
15. ANNEXURE - XV: Responsibility/ Work Scope Matrix
16. ANNEXURE - XVI : Instrument Process Connection

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ANNEXURE - I : TEST AND CALIBRATION FORM

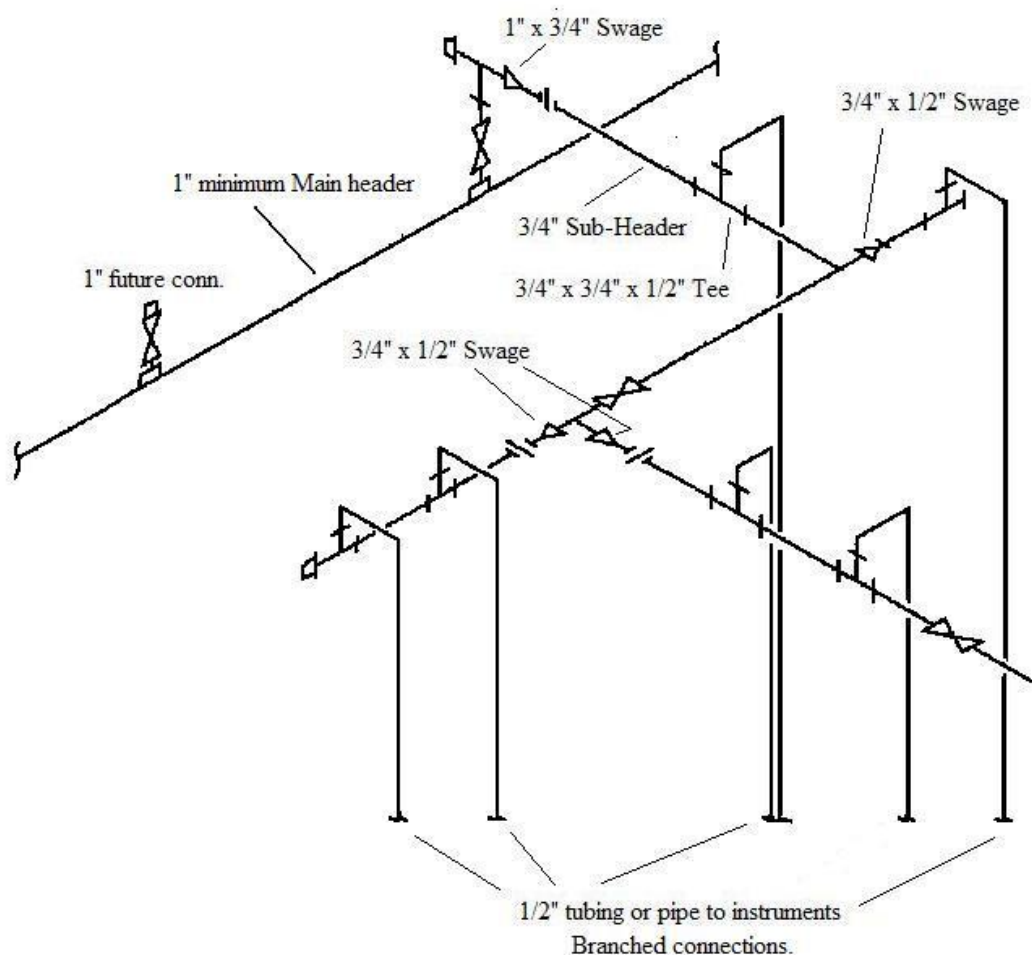
TEST AND CALIBRATION REPORT								
TRANSMITTER (PRESSURE/ DIFFERENTIAL PRESSURE/ TEMPERATURE/ FLOW/ LEVEL)								
						CAL DATE		
						REV No.		
TAG No.		INSTRUMENT TYPE		P&ID No.		SERVICE		
INST RANGE		CAL RANGE		MAKE		MODEL		
CALIBRATION TEST								
INPUT %		APPLIED PRESSURE/ RESISTANCE ETC.	STANDARD OUTPUT (IN mA)	ACTUAL OUTPUT (IN mA)	TRANSMITTER READING	DCS READING	ERROR	REMARKS
RISING	0							
	25							
	50							
	75							
	100							
FALLING	100							
	75							
	50							
	25							
	0							
MASTER EQUIPMENT DETAIL								
SNo.	NAME	MAKE	MODEL No.	CERTIFICATE No.	CERTIFYING AGENCY	CAL DATE	VALID UPTO	
1	CALIBRATOR							
2								
3								
	CALIBRATED BY		WITNESSED BY			REMARKS		
NAME								
SIGN								

Note : Calibration Certificates of all Master calibration equipment shall be attached.

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ANNEXURE - II : PNEUMATIC INSTRUMENTS – AIR SUPPLY BRANCHING CONNECTIONS



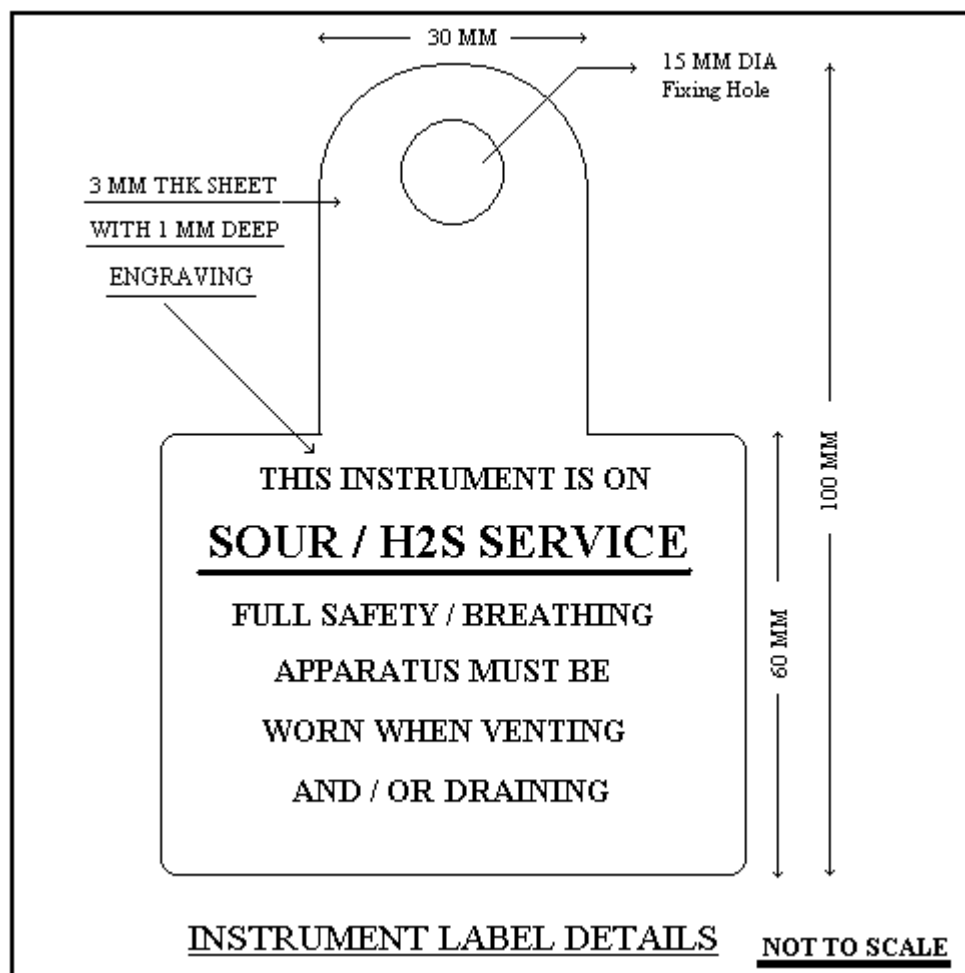
Notes:

1. All connections shall be taken from the top of the header. Branch connections from headers/ sub-headers shall be with SS 316 instrument isolation valves for air tubing to individual instruments. Other details shall be as per FS-3507.
2. ANSI Class# ratings for air piping and pipe fittings on the air headers shall be as per the Piping Specification, including that of the first block valve and swage/ pipe nipples.

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**ANNEXURE - III : LABEL DETAILS FOR INSTRUMENTS/ SYSTEMS
HANDLING H₂S**




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ANNEXURE - IV : FORM-A: TECHNICAL QUESTIONNAIRE

TECHNICAL QUESTIONNAIRE (FORM-A)	
Project:	Doc. No.:
This questionnaire shall be completely filled in and submitted to the Contractor by the Vendor. Vendor shall sign/ date and affix his seal to this form.	
A) SCOPE OF SUPPLY	Indicate answers by ✓ in the appropriate <input type="checkbox"/> boxes.
(I) Is the vendor in total agreement with his scope of supply as per Contractor's Material Requisition (MR)?	<input type="checkbox"/> YES <input type="checkbox"/> NO
(II) If NOT in total agreement, indicate in which of the following deviation is required:	
a) Data Sheets	<input type="checkbox"/> YES <input type="checkbox"/> NO
b) Specifications	<input type="checkbox"/> YES <input type="checkbox"/> NO
c) Contractor's Vendor Data Requirement Schedule (VDRS)	<input type="checkbox"/> YES <input type="checkbox"/> NO
d) QA/ QC requirements (Inspection & Testing Requirement)	<input type="checkbox"/> YES <input type="checkbox"/> NO
If answer is 'YES' for any of the above in A (II), exact deviation required shall be described in detail indicating the appropriate clause(s) in attached Form-B. If no deviation is indicated, then vendor to specify NIL in Form-B and it will be assumed that all the requirements of the scope shall be complied with and no deviations whatsoever shall be accepted after the placement of order. Vendor shall submit filled in Form-B, duly signed & stamped.	
1. Whether total system supply is in Vendor's scope, are there any items vendor wishes to add to achieve total system completion in all respects? (If 'Yes' details to be given)	<input type="checkbox"/> YES <input type="checkbox"/> NO
2. Does the bid include	
a) Commissioning spares	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
b) Maintenance/ operational spares (1 year)	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
d) Special tools & Tackles	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
e) Construction spares & consumables	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
3. Others:	
a) Are Mounting accessories, if any, included in bid?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
b) Are Special installation procedures, if any, included in bid?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
c) Is Supervision of installation in Vendor scope?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
d) Is Installation in Vendor scope?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
e) Is Supervision of commissioning in Vendor scope?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
f) Is Commissioning in Vendor scope?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
4. Does the bid include:	
a) Power requirement	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA

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b) Special Cable requirement				<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
c) Special Calibration equipment				<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
(Extra charges, if any, for the above to be indicated in the bid)				
B) INSPECTION/ CERTIFICATE				
1. Has Vendor indicated in bid detailed inspection procedures being carried out by him?				<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
2. Any special inspection to be carried out other than those required as per bid?				<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
3. Can Vendor furnish certificate from competent authorities as indicated below after order placement:				<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
SNo.	CERTIFICATION FOR	CODE No.	NAME OF CERT. AUTHORITY	
a)	Explosion proof housing			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
b)	Intrinsically Safe			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
c)	Weatherproof housing			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
d)	Indian Boiler Regulation approval			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
e)	Fire Safe Valves			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
f)	Flame Retardant Cables			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
g)	Fire Resistant Cables			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
h)	Others (please specify)			<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> NA
C) DOCUMENTATION (VENDOR OFFER)				
Referring to Contractor's Vendor Document Requirement Schedule (VDRS), Vendor offer shall include the following:				
1. Cover sheet indicating doc. number, revision number, equipment/ package description and Vendor's name with date & details.				<input type="checkbox"/> YES
2. Scope of supply sheet with sub-vendor list				<input type="checkbox"/> YES
3. Filled in Form-A "Technical Questionnaire", duly signed & stamped by Vendor				<input type="checkbox"/> YES
4. Filled in Form-B "Deviation List", duly signed & stamped by Vendor				<input type="checkbox"/> YES
5. Filled in Form-C "List of Commissioning Spares", duly signed & stamped by Vendor				<input type="checkbox"/> YES
6. Filled in Form-D "List of One Year Operational Spares", duly signed & stamped by Vendor.				<input type="checkbox"/> YES
7. Filled in Form-E "List of Special Tools & Tackles", duly signed & stamped by Vendor.				<input type="checkbox"/> YES
8. Filled in Form-F "List of Construction spares & Consumables", duly signed & stamped by Vendor.				<input type="checkbox"/> YES
9. Filled in Form-G "Vendor weight control data sheet", duly signed & stamped by Vendor				<input type="checkbox"/> YES

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10. Catalogue /Leaflets/ Technical literature for the offered Instrument/ System	<input type="checkbox"/> YES
11. Filled in data sheets, duly signed & stamped by Vendor.	<input type="checkbox"/> YES
12. Typical GA drawing showing overall dimension, C.O.G & weight details for the Instrument/ System.	<input type="checkbox"/> YES
13. Other documents/ drawings shall as per Contractor's VDRS	<input type="checkbox"/> YES
D) VENDOR TO CONFIRM THE COMPLIANCE TO THE FOLLOWING SPECIFICATION/ DESIGN DOCUMENTS	
1. CONTRACTOR'S DATASHEET FOR APPLICABLE INSTRUMENT/ SYSTEM	<input type="checkbox"/> YES
2. APPLICABLE FUNCTIONAL SPECIFICATIONS	<input type="checkbox"/> YES
3. INSTRUMENT PROCESS DATASHEETS	<input type="checkbox"/> YES
4. INSTRUMENTATION DESIGN CRITERIA	<input type="checkbox"/> YES
5. PIPING MATERIAL SPECIFICATION	<input type="checkbox"/> YES
6. FUNCTIONAL SPECIFICATION FOR PROTECTIVE COATING	<input type="checkbox"/> YES
<div style="display: flex; justify-content: space-between; margin-top: 20px;"> <div>VENDOR'S SEAL/ STAMP</div> <div>VENDOR'S SIGNATURE & DATE</div> </div>	

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09 ANNEXURE - V : FORM-B - COMPLIANCE TO BID SPECIFICATIONS

COMPLIANCE TO BID SPECIFICATIONS (FORM-B)

Project:

Doc. No.:

SNo.	Document Clause No.	Requirement	Vendor's Deviation With Reasons

Notes:

1. Vendor should fill in this form, the deviations, if any, to the Bid requirements. In case of no deviation, Vendor should fill "NIL" in the 'Deviation' column.
2. Deviations, not specified in this Form-B, but indicated elsewhere in the Vendor documents shall not be considered for review/ approval and it will be presumed that Vendor will comply all requirements stipulated in Bid.
3. Where minor deviations persist, List of Clarifications shall be submitted for approval.

VENDOR'S SIGNATURE, SEAL & DATE

DEC'S SIGNATURE, SEAL & DATE

CONTRACTOR'S SIGNATURE, SEAL & DATE

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ANNEXURE - VI : FORM-C – LIST OF COMMISSIONING SPARES

LIST OF COMMISSIONING SPARES (FORM-C)

Project:			Doc. No.:		
SNo.	Part Number	Description	Quantity	Unit price *	Total price *

*Currency :

Note:

Vendor should state in this form a list of commissioning spares, which are required for the purpose of commissioning of the offered Instrument/ System. If commissioning spares are not required, then Vendor should fill "NIL" in the respective column.

VENDOR'S SIGNATURE, SEAL & DATE

CONTRACTOR'S SIGNATURE, SEAL & DATE

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ANNEXURE - VII : FORM-D – LIST OF ONE YEAR OPERATIONAL SPARES

<u>LIST OF ONE YEAR OPERATIONAL SPARES (FORM-D)</u>					
Project:			Doc. No.:		
SNo.	Part Number	Description	Quantity	Unit price *	Total price *

***Currency :**

Note:
Vendor should state in this form a list of ONE YEAR operational spares, which are essential for one year operation/ maintenance of the offered Instrument/ System. If operational spares are not required, then Vendor should fill “NIL” in the respective column.

VENDOR’S SIGNATURE, SEAL & DATE

CONTRACTOR’S SIGNATURE, SEAL & DATE

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09 ANNEXURE - VIII : FORM-E – LIST OF SPECIAL TOOLS & TACKLES

LIST OF SPECIAL TOOLS & TACKLES (FORM-E)

Project:	Doc. No.:

SNo.	Item Description	Quantity	Unit Rate *	Total price *	Remarks

***Currency:**

Note:

Vendor should state in this form, list of special Tools and Tackles which are essential for the regular operation and maintenance of the offered Instrument/ System. If NO such special tools & tackles are required, then vendor should fill in “NIL” in the respective column.

VENDOR’S SIGNATURE, SEAL & DATE

CONTRACTOR’S SIGNATURE, SEAL & DATE

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09 ANNEXURE - IX : FORM-F – LIST OF CONSTRUCTION SPARES & CONSUMABLES

LIST OF CONSTRUCTION SPARES & CONSUMABLES (FORM-F)

Project:			Doc. No.:		
SNo.	Item Description	Quantity	Unit Rate *	Total price *	Remarks

***Currency:**

Notes:

- Any loose items and/ or equipment, such as gaskets, gland packing, seals etc. used during final testing but needs to be changed before commissioning shall be properly identified, packed, labelled and supplied along with main equipment.
- Vendor shall supply lubricants, chemicals and such consumables along with main equipment.
- Calibration aids, gases etc. that are in Vendor's scope of supply shall also be supplied along with main equipment.
- Spares/ consumables as specified in Note 1, 2 & 3, which are required for the offered equipment/ package, shall be listed in this form by vendor. If NO such spares/ consumables, etc., are required for the offered equipment/ package design, then vendor should fill in "NIL" in the respective column.

VENDOR'S SIGNATURE, SEAL & DATE

CONTRACTOR'S SIGNATURE, SEAL & DATE

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09 ANNEXURE - X : FORM-G – VENDOR WEIGHT CONTROL DATA SHEET

VENDOR WEIGHT CONTROL DATA SHEET (FORM-G)

Project:

Doc. No.:

EQUIPMENT DESCRIPTION:

FILL APPROPRIATE CIRCLE

TOLERANCE CODE :



PRELIMINARY



DESIGN
(CALCULATED)



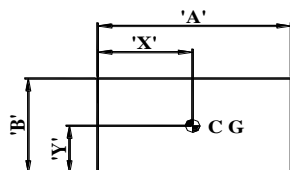
M.T.O

WEIGHTED

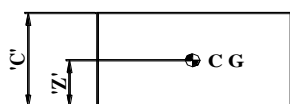


TOLERANCE
±

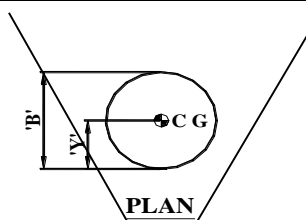
EQUIPMENT ARRANGEMENT TYPES



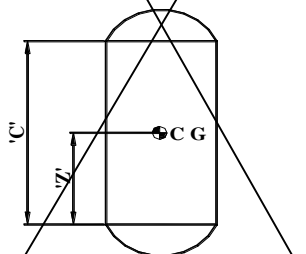
PLAN



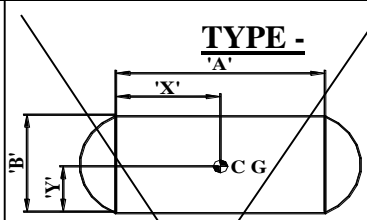
ELEVATION



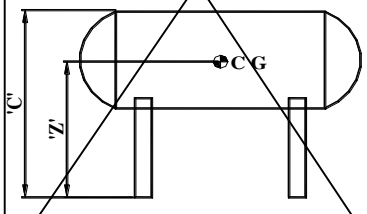
PLAN



ELEVATION



PLAN



ELEVATION

ITEM / TAG No.	TYPE (I / II / III)	* WEIGHTS (kgs)			* DIMENSION (in mm)			* C.O.G (Dry / Opt.) (In mm)		
		DRY	OPT.	TEST	A	B	C	X	Y	Z

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09 ANNEXURE - XI : FORM-H – EQUIPMENT WEIGHT CERTIFICATE

<u>EQUIPMENT WEIGHT CERTIFICATE (FORM-H)</u>		
Project:		Doc. No.:
VENDOR	CONTACT : TEL. No.	REF. DWG. No.
<u>METHOD OF WEIGHING:</u> (e.g. Scales, Load cells etc.) Vendor to prescribe method used.		
	DATE OF LAST CALIBRATION	SPECIFIED ACCURACY REQUIREMENT
		± %
	<u>NOTE:-</u>	
<u>RESULT OF WEIGHING</u> TOTAL EQUIPMENT DRY WEIGHT (Excluding packing, temporary protection etc.)		
		METRIC TONNES
<u>ALLOCATED WEIGHT</u> (Weight estimate agreed by Contractor and Vendor).		
		METRIC TONNES
<u>REASONS FOR VARIATION BETWEEN ALLOCATED WEIGHT AND CERTIFIED WEIGHT</u>		
WEIGHING ADDRESS	WITNESSED BY	
	FOR VENDOR	FOR CONTRACTOR
	Representative	Representative
Date:	Signature	Signature

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ANNEXURE - XII : FORM-I – VENDOR DCI/ MCI

VENDOR DCI/ MCI (FORM-I)						
Project:			Doc. No.:			
SNo.	DRAWING/ DOCUMENT No.	DESCRIPTION	SCH. / ACT.	REV x	REV x	REMARKS
			SCH.			
			ACT.			
			SCH.			
			ACT.			
			SCH.			
			ACT.			
			SCH.			
			ACT.			
			SCH.			
			ACT.			
			SCH.			
			ACT.			
			SCH.			
			ACT.			
			SCH.			
			ACT.			
			SCH.			
			ACT.			

VENDOR'S SIGNATURE, SEAL & DATE

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ANNEXURE - XIII : FORM-J – VENDOR DOCUMENT REVIEW

<u>VENDOR DOCUMENT REVIEW (FORM-J)</u>	
Project:	Doc. No.:
CONTRACTOR'S NAME	
DEC NAME	
<p style="text-align: center;"><u>APPROVAL STATUS</u></p> <p><input type="checkbox"/> A APPROVED</p> <p><input type="checkbox"/> B APPROVED WITH COMMENTS, REVISE AND RESUBMIT FOR APPROVAL. WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED.</p> <p><input type="checkbox"/> C NOT APPROVED, REVISE AND RESUBMIT FOR APPROVAL.</p> <p><input type="checkbox"/> D RECEIVED FOR INFORMATION ONLY</p>	
<p>Permission to proceed does not constitute acceptance of design and calculations, test methods or materials developed or selected by Vendor and does not relieve Vendor from full compliance with contractual or other obligations nor detract from any of Contractor's/ Company's rights.</p>	
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ANNEXURE - XIV : FORM-K – UTILITIES REQUIREMENT

UTILITIES REQUIREMENT (FORM-K)		
Project:	Doc. No.:	
The Vendor should state in this form, list of utilities required for the normal operation of the system covered in the requisition.		
Utilities	Available	Required by Vendor
Electric Power (Non-UPS)		
AC:		
DC:		
For Instruments		
Electric Power (UPS)		
AC:		
DC:		
For Instruments		
Instrument Air	<u>Unit</u>	
Pressure – Min / Nor / Max / Design	Kg/cm ² g	
Temperature – Min / Nor / Max / Design	°C	
Consumption		
Utility Air	<u>Unit</u>	
Pressure – Min / Nor / Max / Design	Kg/cm ² g	
Temperature – Min / Nor / Max / Design	°C	
Consumption		
Water	<u>Unit</u>	
Pressure – Operating / Design	Kg/cm ² g	
Temperature – Operating / Design	°C	
Consumption		
Steam	<u>Unit</u>	
Pressure – Operating / Design	Kg/cm ² g	
Temperature – Operating / Design	°C	
Consumption		
Fuel Gas	<u>Unit</u>	
Pressure – Operating / Design	Kg/cm ² g	
Temperature – Operating / Design	°C	
Consumption		
Fuel Oil	<u>Unit</u>	
Pressure – Operating / Design	Kg/cm ² g	
Temperature – Operating / Design	°C	
Consumption		
Inert Gas	<u>Unit</u>	
Pressure – Operating / Design	Kg/cm ² g	
Temperature – Operating / Design	°C	
Consumption		
Cooling Water	<u>Unit</u>	
Pressure – Operating / Design	Kg/cm ² g	
Temperature – Operating / Design	°C	
Consumption		
VENDOR'S SIGNATURE, SEAL & DATE		CONTRACTOR'S SIGNATURE, SEAL & DATE

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09 ANNEXURE - XV : RESPONSIBILITY/ WORK SCOPE MATRIX

<u>WORK SCOPE MATRIX</u>					
Project:			Doc. No.:		
The Responsibility/ Work Scope Matrix shall be filled by LSTK Contractor to indicate responsibilities of DEC, Vendor/ Sub-vendor and LSTK Contractor.					
S/ N	Description/ Activity	Responsibility			Remarks
		Contractor	DEC	Vendor	
1.	Design & Engineering				
2.	Manufacturing				
3.	Inspection				
4.	Testing				
5.	FAT & SAT				
6.	Installation				
7.	Installation Assistance				
8.	Commissioning				
9.	Commissioning Assistance				
10.	Training				
11.	Documentation				
CONTRACTOR'S SIGNATURE, SEAL & DATE		DEC'S SIGNATURE, SEAL & DATE		VENDOR'S SIGNATURE, SEAL & DATE	

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ANNEXURE - XVI : INSTRUMENT PROCESS CONNECTION : 1 of 2

SN _o .	INSTRUMENT TYPE	VESSEL/ STAND PIPE CONNECTION	FIRST BLOCK VALVE	INSTRUMENT CONNECTION
1	EXTERNAL DISPLACER LEVEL INSTRUMENT ON VESSEL	2" FLGD	2" FLGD	2" FLGD
2	EXTERNAL DISPLACER LEVEL INSTRUMENT ON STANDPIPE	2" FLGD	2" FLGD	2" FLGD
3	INTERNAL DISPLACER LEVEL INSTRUMENT	4" FLGD	-	4" FLGD
4	EXTERNAL BALL FLOAT LEVEL INSTRUMENT ON VESSEL	2" FLGD	2" FLGD	1" SW
5	EXTERNAL BALL FLOAT LEVEL INSTRUMENT ON STANDPIPE	1" SW/ FLGD	1" SW/ FLGD	1" SW
6	INTERNAL BALL FLOAT LEVEL INSTRUMENT	4" FLGD	-	4" FLGD
7	LEVEL GAUGE ON VESSEL	2" FLGD	2" FLGD	¾" SCR D
8	LEVEL GAUGE ON STANDPIPE	¾" SW/ FLGD*	¾" SW/ FLGD	¾" SCR D
9	D.P INSTRUMENT ON VESSEL	1½" FLGD	1½" FLGD	½" SCR D
10	D.P INSTRUMENT ON STAND PIPE	¾" SW/ FLGD*	¾" SW/ FLGD	½" SCR D
11	DIAPHRAGM SEAL D.P INSTRUMENT ON VESSEL	3" FLGD	3" FLGD	3" FLGD
12	EXTENDED D.P INSTRUMENT ON VESSEL	4" FLGD	-	4" FLGD
13	D.P TUBE LEVEL INSTRUMENT	1½" FLGD	½" SW (BY INST)	½" SCR D
14	TANK LEVEL INSTRUMENT (MECH.), [PRESSURIZED]	1½" FLGD	1½" FLNGD (BY INST)	1½" SCR D
15	TANK LEVEL INSTRUMENT (SERVO), [PRESSURIZED]	6" FLGD	6" FLGD (BY INST)	6" FLGD
16	PRESSURE INSTRUMENTS ON VESSEL	1½" FLGD	1½" FLGD	½" SCR D
17	DIAPHRAGM SEAL PRESSURE INSTRUMENT ON VESSEL (SCR D)	1½" FLGD	1½" FLGD	½" SCR D
18	DIAPHRAGM SEAL PRESSURE INSTRUMENT ON VESSEL (FLGD)	1½" FLGD	1½" FLGD	1½" FLGD
19	THERMOWELL	1½" FLGD	-	1½" FLGD
20	STANDPIPE	2" FLGD MIN.	-	2" FLGD
21	TANK LEVEL INSTRUMENT (MECH.), [ATMOSPHERIC]	1½" FLGD	-	1½" SCR D
22	TANK LEVEL INSTRUMENT (SERVO), [ATMOSPHERIC]	6" FLGD	-	6" FLGD

NOTES:

1. **SCR D: SCREWED; FLGD: FLANGED; SW: SOCKET WELD**
2. FOR ANY OTHER INSTRUMENT NOT REFERRED ABOVE, THE CONNECTION DETAILS SHALL BE AS PER INDIVIDUAL REQUIREMENT.

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3. ALL FLANGE/ SW RATING SHALL BE AS PER PIPING SPECIFICATION.
4. IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED FIRST ISOLATION VALVES ARE PROVIDED, BOLTING AND GASKET SHALL BE IN PIPING SCOPE.
5. * MEANS AS PER PIPING SPECIFICATIONS.

ANNEXURE - XVI : INSTRUMENT PROCESS CONNECTION : 2 of 2

SNo	TYPE OF INSTRUMENTS	WHERE PIPING CLASS PRESCRIBES SCREWED CONNECTIONS			WHERE PIPING CLASS PRESCRIBES SOCKET WELD CONNECTIONS			WHERE PIPING CLASS PRESCRIBES FLANGED CONNECTIONS		
		Process Connection	1st Block Valve	Instrument Connection	Process Connection	1st Block Valve	Instrument Connection	Process Connection	1st Block Valve	Instrument Connection
1	ORIFICE FLOW METER	½" SCRD	½" SCRD	½" SCRD	½" SCRD *	½" SW	½" SCRD	½" SCRD *	½" FLGD	½" SCRD
2	ANNUBAR	1½" FLGD	1½" FLGD (BY INSTT)	1½" FLGD 4	1½" FLGD	1½" FLGD (BY INSTT)	1½" FLGD 4	1½" FLGD	1½" FLGD (BY INSTT)	1½" FLGD 4
3	PRESSURE INSTRUMENT	¾" SCRD	¾" SCRD	½" SCRD	¾" SW	¾" SW	½" SCRD	¾" FLGD	¾" FLGD	½" SCRD
4	DIAPHRAGM SEAL PRESSURE INSTRUMENT (SCRD)	¾" SCRD	¾" SCRD	½" SCRD	¾" SW	¾" SW	½" SCRD	¾" FLGD	¾" FLGD	½" SCRD
5	DIAPHRAGM SEAL PRESSURE INSTRUMENT (FLGD)	1½" FLGD	1½" FLGD	1½" FLGD	1½" FLGD	1½" FLGD	1½" FLGD	1½" FLGD	1½" FLGD	1½" FLGD
6	THERMOWELL	1½" FLGD	-	1½" FLGD	1½" FLGD	-	1½" FLGD	1½" FLGD	-	1½" FLGD

NOTES:

1. **SCRD: SCREWED; FLGD: FLANGED; SW: SOCKET WELD**
2. FOR ANY OTHER INSTRUMENT NOT REFERRED ABOVE, THE CONNECTION DETAILS SHALL BE AS PER INDIVIDUAL REQUIREMENT.
3. ALL FLANGE/ SW RATING SHALL BE AS PER PIPING SPECIFICATION.
4. IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED FIRST ISOLATION VALVES ARE PROVIDED, BOLTING AND GASKET SHALL BE IN PIPING SCOPE.
5. INSTALLATION OF ALL INLINE INSTRUMENTS SHALL BE IN PIPING SCOPE.
6. * MEANS SEAL WELDING REQUIRED
7. \$ MEANS CONNECTIONS FOR DP INSTRUMENTS IS ½ "SCRD.



Offshore Design
Section
Engineering
Services
ISO – 9001:2000

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AND LIFE SAVING
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(PROCESS PLATFORM)**

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MECH

SECTION 3.7

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**MECHANICAL, SAFETY AND
LIFE SAVING EQUIPMENT
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KNS	NM	AJ	60	14/08/2018	7
NM	NG	SKN	58	26/11/2014	6
KS	VBD	JSS	52	11/05/2009	5
BG/PLN	VBD	JSS	71	04/03/2008	4
SRP	VBD	SKG	51		3

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ODS/SOF/004

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ODS/SOP/023

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3.7.2 Codes and Standards and Functional Specifications

3.7.3 Environment Design Criteria

3.7.4 Area Classification

3.7.5 General Engineering Requirements

3.7.6 Major Equipments


3.7.7 Life Saving Equipments

3.7.8 Personnel Protection System

3.7.9 Hot Surface Protection

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3.7.1

SCOPE OF THIS DOCUMENT

This document defines the design criteria for Mechanical, Safety &Life Saving Equipment applicable for offshore Process platforms. As such this document describes design requirement of some equipment which are not envisaged in the current project. Hence, for the present project, only those items / equipments shall be referred to which are included in the basic bid work.

The purpose of this document is to describe the design considerations to be followed during detail design of the offshore Process platform equipments.

This is detailed design criteria for all the mechanical equipments. The relevant portion of the design criteria shall be read in conjunction with process description & process design criteria and Functional specification given elsewhere in the bid. In case of any conflict in the Mechanical data sheet with Process data sheet the latter shall govern.

3.7.2

CODES AND STANDARDS AND FUNCTIONAL SPECIFICATIONS


3.7.2.1


Codes and Standards


The equipment, packages and systems shall be designed, selected and engineered in accordance with latest editions of the following main codes /standards / recommended practices together with all current applicable Regulations except as modified by this design criteria / functional specifications.


ASME Section-II, Div-I	Boilers and Pressure Vessel Code- Materials
ASME Section-VIII, Div-I	Boilers and Pressure Vessel Code
ASME Section-IX	Boilers and Pressure Vessel Code- welding and Brazing qualification
ASME PTC 10	Power test codes for Compressors and Exhausters
ASME PTC 22	Performance test code for Gas Turbine Power Plants
ANSI B 31.3	Process piping
API Spec. 2C	Offshore Crane


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	API RP 2D	Operation and Maintenance of Offshore crane		
	API RP 2G	Production Facilities of Offshore Structure		
	API RP 14C	Analysis, Design, Installation, Testing of Basic Surface Safety Systems for Offshore Production Platforms.		
	API-RP-14 E	Recommended practice for Design and installation of offshore production platform piping system		
	API RP 14F/14FZ	Design & Installation of Electrical system for offshore production system		
	API RP 14G	Fire prevention and control on open type offshore production platforms.		
	API RP 14J	Recommended Practice for Design and Hazards analysis for Offshore Production Facilities		
	API RP 75	Recommended Practice for Development of a Safety and Environmental Management Program for Offshore Operations and Facilities		
	API RP 500	Electrical Hazardous Area Classification		
	API RP 520	Design and Installation of relieving system in Refineries		
	API RP521	Guide for pressure relief and depressurizing system		
	API RP 550	Installation of Refinery instruments and control system		
	API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries		
	API 613	Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services		
	API 614	Lubrication shaft sealing and control oil system of special purpose application		
	API 615	Sound controls of mechanical equipment for refinery service.		
	API 616	Gas Turbine for the petroleum, chemical, and Gas industry		
	API 617	Axial and Centrifugal Compressors and Expander-compressors for petroleum, chemical and Gas Industry services.		
	API 618	Reciprocating Compressor for Petroleum, Chemical and Gas Industry Services		
	API 619	Rotary Type Positive Displacement Compressor (Screw Compressor)		
	API 650	Welded Steel tank for oil storage		
	API 660	Shell and Tube Heat Exchangers for General refinery services		
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	API 661	Air Cooled Heat Exchangers for General Refinery Services.		
	API 662	Plate Type Exchanger		
	API 670	Machinery protection system		
	API 671	Special purpose coupling for Refinery Services		
	API 674	Positive Displacement Pumps Reciprocating		
	API 675	Positive Displacement Pumps Controlled volume		
	API 676	Positive Displacement Pumps – Rotary		
	API 677	General Purpose Gear Units for Refinery Services		
	API 681	Liquid Ring Vacuum Pumps And Compressors for Petroleum, Chemical, And Gas Industry Services		
	API 682	Pumps-Shaft Sealing Systems		
	API 12 GDU	Glycol type gas dehydration unit		
	API Publication 2030	Application of Fixed Water Spray System for Fire Protection in the Petroleum Industry		
	API SPEC 12J	Oil And Gas Separators		
	ASHRAE Standards	American Society of Heating, Refrigeration and Air Conditioning Engineers		
	ASTM	American Society for Testing and Material		
	ANSI	American National Standards Institute		
	ANSI B 1.1	Screw threads		
	ANSI B 16.5	Steel pipe flanges and flange fittings		
	AGMA	American Gear Manufacturer’s Association		
	AWS	Welding hand book		
	BS 3243	Specifications for hand operated chain blocks		
	BS 4465	Electrical Hoists		
	BS 5514 (Part 1 to 7)	Reciprocating internal combustion engines Performances.		
	EEMUA (Publication No 107)	Recommendation for the protection of Diesel engines operating in hazardous area		
	BS-EN-1834-1:2000	Reciprocating IC engine –Safety requirements for design Construction of engine for use in potentially explosive environment. Part –I, group		
	IS- 3938	Spec. for Elect. wire rope hoist		
	IS-3832	Chain Pulley Blocks		
	BS EN13157	Cranes. Safety- Hand powered lifting equipment		
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	IS-15683	Portable fire extinguishers- performance and construction		
	IS-2171	Portable Fire Extinguisher dry powder (Cartridge type)		
	IS 2190	Selection, Installation and Maintenance of First Aid Fire Extinguishers- Code of practice.		
	IS 2878	Specification for Fire Extinguishers, Carbon di oxide type(Portable and Trolley mounted)		
	IS 4947	Specification for gas cartridges for use in Fire Extinguishers.		
	IS 10658	Specification for Higher capacity Dry Powder Fire Extinguisher (Trolley Mounted)		
	ISO-9000 Series	Quality Assurance		
	NGO-DD-ANSI-LC-6	Natural Gas Operated Double Diaphragm Pump		
	ANSI/HI 10.1 - 10.5	American National Standard for positive displacement Air operated pumps		
	ANSI/HI -10.6	American National Standard for Test of air operated pump test		
	NFPA 10	Portable Fire Extinguisher		
	NFPA11	Standard for low expansion Foam		
	NFPA12	Standard on Carbon Dioxide Extinguishing systems		
	NFPA13	Installation of sprinkler system		
	NFPA14	Standard for the installation of Standpipe, private Hydrant and Hose system		
	NFPA15	Water Spray Fixed systems for fire protection		
	NFPA16	Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems.		
	NFPA 17	Dry Chemical Extinguishing System		
	NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection		
	NFPA 25	Inspection, Testing and Maintenance of Water Based Fire Protection System		
	NFPA 2001	Standard on Clean Agent Fire Extinguishing Systems		
	NACE-MR-01-75	Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment		
	IEC	International Electrical Commission		
	NEC	National Electrical Code		
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	NEMA	National Electrical Manufacturers Association		
	OSHA	Occupational Safety and Health Act		
	OTR	UK HSE offshore technology report 2001/068		
	SOLAS	International Convention of Safety of Life at Sea		
	LSA code	Life Saving Appliance Code		
	SMACNA Standards	Sheet Metal and Air Conditioning Contractors National association		
	TEMA	Tubular Exchanger manufacturer’s Association.		
	HIS	Hydraulic Institute standards		
	OISD	Oil Industry Safety Directorate		
	UL	Underwriters Laboratories		
	ABS	American Bureau of Shipping		
	Offshore Installation Guidance on Design & Construction, Department of Energy, UK (Part - II) - Section 5.9: Noise & Vibration.			
	<ul style="list-style-type: none">Any supplementary codes specified within above codes, along with those codes mentioned in company’s Functional Specifications and their attachments shall also form part of this document.For equipment and packages not covered by above codes/standard, the best industrial practice prevalent in offshore oil production industry shall apply.			
3.7.2.2	Reference Functional Specifications			
The equipments and activities under this design criterion shall also be designed, manufactured and tested / carried out, in accordance with the requirements of the following functional specifications:				
	SPEC NO	DESCRIPTION		
	MECHANICAL			
	5001	Functional specification for centrifugal pumps		
	5002	Functional Specification for noise limit		
	5004	Functional Specification for equipment vibration		
	5055F	Functional Specification OCI transfer pump		
	5055C	Functional specification for reciprocating pump- controlled volume		
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	5067F	Functional specification for Dry Chemical Skid with hose reels		
	5078F	Functional specification for Sewage Treatment Plant		
	5079	Functional specification for Sewage Treatment Plant (Biological Type)		
	5086F	Functional specification for rotary gear pump		
	5095F	Functional Specification for fuel gas conditioning Skid		
	5100P	Specification for packaged equipment- Process platform		
	5103	Functional specification for Clean Agent Fire Extinguishing system		
	5105	Functional specification for fuel gas compressor		
	5205	Functional specification for Reciprocating Pump		
	5206F	Functional specification for Fire water pump		
	5301	Functional specification for Deck crane		
	5401	Functional Specification for LP Gas Compressor Package		
	5402	Functional specification for IA/UA compressor package		
	5403	Functional specification for Packaged Reciprocating compressor		
	5404 F	Functional specification for process gas compressor		
	5405F	Functional specification for Chlorinator unit		
	5406	Functional Specification for Breathing Air Compressor Package		
	5409F	Functional specification for Starting air compressor		
	5410 F	Functional Specification for Motor Driven Centrifugal Compressor		
	5501	Functional specification for gas turbine		
	5502F	Functional specification for Diesel Engine		
	5601	Functional specification for Unfired pressure vessel		
	5602F	Functional specification for Vapour Compression Portable water maker package		
	5610F	Functional specification for Reverse Osmosis type water maker		
	5701F	Functional specification for air cooled exchanger		
	5702F	Functional specification for shell and tube exchanger		
	5703	Functional Specification for Waste Heat Recovery Unit		
	5801	Functional specification for Gas dehydration package		
5802	Functional specification for Produced water conditioning			
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		package		
	5901F	Functional specification for HVAC		
	5902F	Functional specification for diesel centrifuge		
	5903F	Functional specification for Inert gas generator		
	5904	Functional specification for Sump Caisson with Blowcase		
	5905	Functional specification for Jet Fuel System		
	5906	Functional specification for Flare Tip (HP Gas)		
	5907	Functional specification for N2 Gas Generator – Membrane Type		
	5908	Functional specification for Amine Based Gas sweetening Unit		
	5912 F	Functional specification for UV sterilizer		
	SAFETY			
	5101	Functional specification for safety studies		
	5102	Functional safety specification		
	5104	Functional specification for HSE requirement		
	ELECTRICAL			
	VOL II Sect 3.5	Electrical Design Criteria and relevant functional specifications		
	PIPING			
	Vol II Sect 3.3	Piping design criteria		
	2004-A	Functional specification for Piping Design		
	2004-B	Functional specification for piping fabrication and installation		
	2006	Functional specification for Insulation of Piping and Equipment Insulation		
	2009F	Functional specification for Welding And NDT		
	1060	VENDOR DATA REQUIREMENT		
	STRUCTURAL			
	2005	Specification For Protective Coating		
	PROCESS			
	Vol II Section 3.2	Process Design Criteria		


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	Vol II	Section 6.0 Commissioning Procedures & Performance tests (Process Platform)				
	INSTRUMENTATION					
		Instrumentation Design Criteria and relevant functional specifications				
3.7.3 ENVIRONMENT DESIGN CRITERIA						
3.7.3.1 Climatic conditions Unless otherwise specified, equipment shall be designed for outdoor location suited to corrosive salt laden, marine environment etc. and containing other corrosive constituents like H ₂ S. Climatic conditions under which equipment shall be designed / operated are detailed elsewhere in the bid document.						
3.7.3.2 Design Life, Availability and Reliability Equipment shall be designed and constructed for continuous operation, outdoor and for a minimum service life as indicated elsewhere in the bid. The contractor shall provide details of the maintenance and overhauls activities; and parts requirements for all scheduled maintenance requirements between start (Zero Hours) and up to & including major overhaul, at the maximum design conditions. The Contractor shall specify the estimated availability figure for the packages. In addition, the Contractor shall furnish its best estimates of Mean Time between Failures (MTBF) and Mean Time to Repair (MTTR) for the equipment concerned. In making assessments of the availability and reliability, contractor will need to estimate maintenance and repair times. For the purpose of making such estimates, the contractor may assume that the spares holding is in accordance with its submitted recommendations unless otherwise stated. The Contractor may also ignore any delay caused by factors not directly related to the package in question, unless a basis for estimating such delays is provided by the Company. In the case of failure modes that make a significant contribution to the overall unavailability, the Contractor may be required to demonstrate that it's assumed repair times can be achieved.						
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	<p>To facilitate the online preventive maintenance and calibration, the Contractor shall provide necessary equipment to achieve the maximum online availability and minimum preventive maintenance down time. Duplex oil filters, test ports, block valves and drain lines for instruments and spaces for ease of maintenance access shall be incorporated in the design to achieve the online trouble shooting and maintenance of each instrument.</p> <p>3.7.4 AREA CLASSIFICATION</p> <p>Electrical and instrumentation equipment shall be suitable for the applicable Hazardous Area classification according to Electrical design criteria enclosed in the bid. All equipment shall be designed to suit the area classification as defined in the Area Classification Drawings (to be developed during detailed engineering) or as indicated in the respective Functional specifications of the Equipment, whichever is more stringent.</p> <p>3.7.5 GENERAL ENGINEERING REQUIREMENTS</p> <p>Various equipments, their capacity and quantity envisaged under this project are indicated in the Description of work (Basic Bid work). As regards Process parameters for these equipments also refer Process design criteria to minimize the allocation of interface responsibility.</p> <p>The design of Mechanical, Safety and Life Saving equipment and facilities shall be done to ensure the following:</p> <ul style="list-style-type: none"> ▪ Safety to personnel and equipment. ▪ Reliability of service. ▪ Minimum fire risk. ▪ Ease of maintenance and convenience of operation. ▪ Adequate provision for future expansion and modification. ▪ Maximum Interchange- ability of equipment. ▪ Protection of all Mechanical equipment. ▪ Fail safe features. ▪ Hook-up provisions with existing facilities, wherever required <p>All packaged equipment shall be supplied as skid mounted, fully assembled, piped, wired and tested as per specifications. Structural steel base frame of skid shall be designed to permit a four point single lift without affecting the equipment mounted on it during lifting and subsequent operational activity.</p>			
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		<p>General requirement for packaged equipments are detailed in functional specification 5100P for Process platform. Equipment falling under package item will be procured complete from a single Vendor who would have sole responsibility for the package performance.</p> <p>Production of documents for information and data for engineering shall be submitted by contractor in accordance with the Vendor data requirements/ Contract Data/Specifications.</p> <p>Estimated and final weights for mechanical equipment / and packages shall be submitted.</p> <p>Equipment shall be designed and selected for continuous duty, unless otherwise specified.</p> <p>Flywheels, sheaves, shafts, coupling and similar hazards shall have removable safety guards which shall be sufficiently rigid to prevent deflection and shall be constructed from non-sparking material.</p> <p>During detailed engineering, the contractor shall furnish all the design details, calculations, drawings for review/approval by the Company.</p> <p>The equipment prone to spillage/leakage/moisture condensation shall be provided with drip pans so as to avoid spillage of any liquid on the decks. Ease of accessibility to drain points and piping connections shall be specified on all equipment that has an oil lubrication or heat transfer system.</p> <p>Maintenance and operational access requirements on all four sides and also on overhead/underneath shall be examined for all equipment while engineering the platform facilities.</p> <p>Contractor shall provide laptop/PCs, pre-loaded with operating system software for maintenance & trouble shooting of all the PLCs and control/ monitoring system , complete with all required software, hardware and all accessories inclusive of cable, adaptors, carrying case etc. to permit uploading & downloading of data and programs, for all equipment/equipment package installed on the platform. Contractor shall also provide two copies of complete system software on CDs/DVDs. Laptop shall be of ultra-light weight and be provided with latest Intel microprocessors, latest version of windows operating system,15 inch monitor, CD combo drive. All software shall be provided with evergreen licenses.</p>		
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<p>Equipment supplied by vendor shall meet painting specification given in Spec 2005 .However, vendor’s painting standard is also acceptable provided it is suitable for offshore application. In such cases vendor’s standard painting procedure shall be submitted for review by the company.</p> <p>Necessary lifting hooks shall be provided for maintenance / repair / replacement.</p> <p>Filled in Data-Sheets as stated in Functional specifications for each item along with the drawings and documents asked for in the specifications will be furnished with the proposal presented for review and approval of the Company.</p> <p>Storage space shall be provided for chemicals and lubricants.</p> <p>Materials for construction of all parts of the equipment shall be compatible with the fluid in contact with that part as per relevant codes, standards and Functional specifications. However for pumps handling sea water the MOC shall be minimum Duplex stainless steel.</p> <p>3.7.5.1 Order of Precedence of specifications:</p> <p>In event of any difference of requirement in the specifications, the order of precedence of specifications shall be as follows:</p> <ul style="list-style-type: none"> - National Statutory requirements. - Scope of work - P & IDs /PFD’s &Process Data Sheets - Design criteria - Functional specification - Codes and standards. <p>However, the differences shall be brought to the notice of the company and decision of the company in this regard shall be final and shall govern the design.</p> <p>3.7.5.2 Contractor data requirements</p> <p>3.7.5.2.1 Documentation Required for Information, Review and Approval shall have the following documents as a minimum:</p>				
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<div> <ul style="list-style-type: none"> ▪ Design Calculations, Design Philosophies for Mechanical equipment/Packages ▪ Purchase specification for all the mechanical equipment/packages as per approved MCI ▪ Safety & Escape Route Layout (shall be endorsed by the Safety Studies agency) ▪ Material handling Study report. ▪ Coarse & Final QRA reports (including HAZID , HAZOP, SIL reports and close out reports). All Safety studies reports shall be endorsed by CA, before submitting to company for information. ▪ All drawings / documents prepared by the Contractor for Company's review. ▪ Pre-Commissioning/ Commissioning Procedures (approved/reviewed by CA) ▪ Operation & maintenance procedures, Control philosophy etc. for all mechanical equipment/packages. ▪ Final As-built documents / drawings duly certified by CA </div> <p>Any other Documentation as indicated in the respective Functional Specification of the Mechanical Equipment/Package.</p> <div> 3.7.5.2.2 Purchase Specification (PS) </div> <p>CONTRACTOR shall submit the completely filled-in PURCHASE SPECIFICATION (PS) of the finally selected equipment make and model for Company's review and approval in two stages.</p> <p>The Purchase Specification (PS) submitted for Company's review/approval shall have the following documents as a minimum:</p> <div> <u>1st Stage: Prelim PS:</u> </div> <div> <ul style="list-style-type: none"> i) Vendor name and Contact Details of the proposed manufacturing /supplying plant. ii) Approved P&ID, Process Flow diagrams (PFDs) and Process Data Sheet (PDS). iii) Deviation List-Form "B" (Vendor shall clearly specify the relevant FS in the deviation Form). iv) Completely filled in Experience Record format / Reference list of the offered equipment completed by the vendor, with brief project details, capacity/Model, and year of supply etc. for offshore application. v) Applicable Certificates </div>				
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<p>vi) Proposed Inspection Requirement Table (IRT)</p> <p>vii) Combined General Arrangement Drawing (GAD) for each skid showing driver, driven equipment and other auxiliary equipment.</p> <p><u>2nd Stage: Final PS:</u></p> <ol style="list-style-type: none"> Detailed Vendor's scope of supply / work. Equipment Layout, area classification drawings (approved copy), filled in Mechanical data sheet (duly reviewed and endorsed by contractor/ contractor's engineering consultant) etc. Following Forms duly filled in: <ol style="list-style-type: none"> Form A - Technical Notes / Engineering Notes Form C - List of Commissioning Spares Form D - List of One year spares (Operational/Maintenance) Form E - List of Special Tools & Tackles Form F - List of Consumables Form G - Vendor weight control Data sheet Form H- Equipment weight certificate Form K – Utilities Requirement (start up, normal operation, shutdown & emergency including power consumption) & Lubricant schedule. Write up on Operation and Control Philosophy Vendor's Product Catalogues/Technical literature Design Calculations, System Sizing/Selection / back calculation of all equipment viz. heat exchangers, filter separator and receiver. MOC of major items Test certificates ,Performance Curves, if applicable P&I Diagram main and auxiliary system like lubrication & sealing systems. P&I D of complete package within the Battery Limits / Package limit including the auxiliary/subsystems. Sub Vendor List including Electrical and Instrumentation items Emergency electrical power requirement of sub systems and complete systems Cross-sectional drawings with bill of materials (driven equipment, driver, gear box, couplings, seal assemblies) Performance Guarantee 				
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		<p>14. Inspection Requirement Table (IRT) (Duly reviewed and approved by Inspection Agency and Certification Agency)</p> <p>15. Details of Instrumentation and Electrical Items.</p> <p>16. Detailed vendor data requirement/schedule</p> <p>17. Functional schematic (as applicable)</p> <p>18. Copy of Approved Suggested Vendor's List</p> <p>19. Any other detail as specified in applicable FS/Standard.</p> <p>20. Final PS to be submitted for approval shall include documents as listed above along with list of accepted deviations.</p> <p>Note: Vendors filled in equipment datasheets /Drawing attached with Purchase Specification shall have been reviewed by the Contractor for ensuring strict compliance to the Bid Specification requirements. Documents must be signed and stamped by the Vendor, Design Consultant, and Contractor as applicable.</p> <p>3.7.5.3 VENDOR PRE-QUALIFICATION REQUIREMENT:</p> <p>Vendor Pre-Qualification Document will be evaluated and approved by the company in accordance to the latest ONGC Vendor Enlistment Procedure and as per the provision of the Contract.</p> <p>3.7.5.4 PACKAGED EQUIPMENT </p> <p>Following is the list of Packaged Equipment. The Vendors for the packaged Equipment shall be selected based on the following:</p> <ul style="list-style-type: none"> ➤ The Vendor (Packager) is the Process Licensor OR the OEM of the main equipment indicated in the List against each package. ➤ If Vendor (Packager) is not a Process Licensor or OEM of main equipment, then the Vendor (Packager) shall submit authorization letter form the ONGC enlisted Vendors of Main equipment for carrying out packaging activity. ➤ The Vendor (Packager) shall give an undertaking that he shall select the vendors for the major items from the Suggested Vendor list of the Company. 		
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All the Major items indicated in the List against each package shall be selected from the Suggested Vendor list of the Company.														
List of Packaged Equipment														
Sl. No.	Packaged Equipment	Criteria for enlistment of vendor for Packaged Equipment - Main Equipment	Major Item within package to be selected from ONGC suggested Vendor List											
1	Instrument / Utility Gas System	Vendor shall be Process Licensor	i) Vessel* ii) For Programmable Logic Controller (PLC) based Systems, PLC shall be from ONGC Suggested Vendor List (SVL). # iii) The process licensor has to select various Instt. Items i.e. Transmitters, PSV/PRV, PCV, SAPCV, Instrumentation Fittings & tubings from ONGC SVL.											
2	HVAC	Vendor shall be Process Licensor or OEM of Compressor or Authorized by Compressor OEM.	i) Compressor ii) Motor iii) Light Fitting iv) For PLC based Systems, PLC shall be from ONGC Suggested Vendor List (SVL). #											
3	Instrument Air Compressor	Vendor shall be OEM of Compressor or Authorized by Enlisted Compressor OEM	i) Compressor ii) Dryer iii) Motor iv) Light Fitting v) For PLC based Systems, PLC shall be from ONGC Suggested Vendor List (SVL). #											
4	Produced Water Conditioning System	Vendor shall be Process Licensor	i) Pumps ii) Vessel* iii) Motor iv) For PLC based Systems, PLC shall be from ONGC Suggested Vendor List (SVL). #											
5	Chemical Storage and Dosing System	Vendor shall be OEM of Chemical Dosing Pump or Authorized by	i) Chemical Dosing Pump ii) Transfer Pump iii) Motor											
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Spec. No														
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		Enlisted Chemical Dosing Pump OEM												
6	a) Nitrogen Generator (Membrane Type)	Vendor shall be OEM of Membrane or Authorized by Membrane OEM	i) Compressor ii)Vessel* iii)Motor iv)Light Fitting v)For PLC based Systems, PLC shall be from ONGC Suggested Vendor List (SVL). #											
	b) Nitrogen Generator (PSA Type)	Vendor shall be OEM of Compressor or Authorized by Enlisted Compressor OEM												
7	Gas Dehydration Unit	Vendor shall be Process Licensor	i) Vessel* ii) Pump iii) Motor iv) Light fitting v) The packager/s has to select various Instt. Items i.e. PLC, DCS, Transmitters, PSV/PRV, PCV, LCV, ILCV, SAPCV, Instrumentation Fittings & tubings, Switches, Flow meters from ONGC SVL.											
8	Gas Sweetening Unit	Vendor shall be Process Licensor	i) Vessel* ii) Pump iii) Motor iv) The packager/s has to select various Instt. Items i.e. PLC, DCS, Transmitters, PSV/PRV, PCV, LCV, ILCV, SAPCV, Instrumentation Fittings & tubings, Switches, Flow meters from ONGC SVL.											
9	Fuel Gas conditioning Skid	Vendor shall be Process Licensor	i) Vessel* ii)The packager/s has to select various Instt. Items i.e. PLC, DCS, Transmitters, PSV/PRV, PCV, LCV, ILCV, SAPCV, Instrumentation Fittings & tubings, Switches, Flow meters from ONGC SVL.											
10	Fire Water Pump	Vendor shall be OEM of Fire Water Pump or Engine or Authorized by Enlisted Pump / Engine	i) Fire water Pump ii)Engine iii)For PLC based Systems, PLC shall be from ONGC Suggested Vendor List (SVL). #											
<table><tr><td>FORMAT NO.</td><td>Ref PROCEDURE No</td><td>ISSUE No</td><td>REV No</td><td>REV DATE</td></tr><tr><td>ODS/SOF/004</td><td>ODS/SOP/023</td><td>01</td><td>00</td><td>21.07.2010</td></tr></table>					FORMAT NO.	Ref PROCEDURE No	ISSUE No	REV No	REV DATE	ODS/SOF/004	ODS/SOP/023	01	00	21.07.2010
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		OEM	
11	Water De-oxygenation Tower	Vendor shall be Process Licensor	i) Vessel* ii)Vacuum Pump ii) Motor iv)For PLC based Systems, PLC shall be from ONGC Suggested Vendor List (SVL). #

* Fabricator for the above Vessels to be selected from one of those Vendors listed in the Suggested Vendor List under item "Fabricator of Pressure Vessels"(Product Sl. No.3). Any fabricator other than as stipulated in Sl. No. 3, selected shall be ASME ‘U’ code stamp authorized fabricator with proven PTR (Past Track Record) of minimum two years of offshore experience and shall be fabricating in the last ten years. Necessary documents are to be submitted / incorporated in Purchase Specification (PS) for review of company.

In case, PLC is not from ONGC’s SVL, then PTR for the PLC used in the offered package should be the same as the one supplied to various Offshore oil and gas project (s) and it shall be supported with either satisfactory Performance feedback certificate(s) from offshore oil and gas end user/s for a minimum period of 2 years; OR Repeat P.O copies from same end user for offshore oil and gas project (s) with a minimum time gap of 2 years from the delivery the date of first purchase order; OR Repeat PO copies from LSTK contractor(s) for the same end user for offshore oil and gas project(s) with a minimum time gap of 2 years from the delivery date of first purchase order.

3.7.5.5 EQUIPMENT LAYOUT


3.7.5.5.1 General


Contractor shall furnish equipment layout drawing for all equipments for Company’s review and approval. Contractor shall ensure that all equipments are appropriately located, logically in sequence of operation, maintenance, other engineering consideration and good engineering practices in the industry.


Development of Layout primarily shall consider the following aspects:

- Safety
- Accessibility
- Operational convenience

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<p>➤ Future Maintenance</p> <p>➤ Area optimization</p> <p>➤ Technical & Engineering Requirements</p> <p>Equipment layout on deck and within skid shall be examined for adequate access for convenient operation, maintenance and replacement of components in every direction. There should be enough space available, for the movement of material handling devices and provision of hooks for area/equipments where permanently installed material handling facilities, or deck crane do not have access.</p> <p>Maintenance, operational and removal of major assemblies / subassemblies of equipment shall be considered while engineering the platform facilities. Space requirement on sides, overhead and underneath shall be considered for such purpose.</p> <p>The clear space requirement all around equipment for maintenance/repair is as stated below. This clear space shall be from outer surface of the insulation. However, for equipment not mentioned below, all around equipment a clear space of 750 mm (minimum) shall be provided for taking up any repair / maintenance activities.</p> <ul style="list-style-type: none"> ➤ 900MM - Minimum clear access between adjacent vessels. ➤ 1500MM - Minimum clear width of operating and servicing areas around diesel driven equipment, turbines and compressors. Must also comply with vendor requirement for the servicing and removal of components. ➤ 900MM - Minimum clear width between pumps, exchangers, small vessels and piping manifold. ➤ 600MM - Minimum clear width between adjacent exchangers in the same service and directly connected. ➤ 900MM - Minimum clear width beyond the end of exchangers (plus tube bundle or cover removal length where applicable). ➤ 900MM- Minimum clearance in front of inspection, cleanout and man way opening, internal removal shall be considered. <p>Maintenance and operational access requirements on all four sides and also on overhead / underneath shall be examined for each equipment while engineering the platform facilities.</p>				
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<p>Handrails of height as indicated in Structural Design Criteria shall be provided around all accessible area, stairs etc. to ensure complete safety.</p> <p>Drum rack shall be of bolted type to facilitate rigging operation.</p> <p>Access platforms shall be provided for the equipment/valves, manholes etc. which are not approachable from the deck floor i.e. 2.0 meters above the floor.</p> <p>Safety route shall be clearly indicated and painted with luminescent green color paint with yellow luminescent paint arrow.</p> <p>All equipments shall be protected from drop object.</p> <p>Clear head clearance of 2.2 meters, shall be available throughout the platform and walkways.</p> <p>Removable hatch shall be provided on the deck so as to lift / remove the single largest assembly.</p> <p>Life rafts shall be installed in self-launching mode. Life raft cradle shall be inclined at an angle 30 degree downward. Along with life raft, scramble net shall be provided.</p> <p>Life Ring Buoy shall be provided on each edge of the platform.</p> <p>Mustering Area shall be identified on the layout. Adequate space (minimum 0.5 m² clear space per person) to accommodate credible number (equal to the capacity of survival craft/ Life raft) of personnel in the mustering area with emergency lighting and communication systems shall be provided so as to ensure safe access to the egress route. The mustering area shall be clear of safety/escape route.</p> <p>3.7.5.5.2 Lay down areas</p> <p>Lay down areas shall be located to allow removal of maintainable equipment from the lower decks as required. An Upper deck lay-down area</p>				
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is to be provided for maintenance and inventory lifts associated with the major items of equipment on this deck.

The corridors from major items of equipment to lay-down areas shall be provided with monorails/ traveling bridge crane etc. suitable for fitting hoists during maintenance activity.

Maintenance access ways shall be designed to handle the highest expected trolley loads and equipment dimensions. “Dropped object” protection and movement philosophies must be developed to ensure safe movement of equipment.

Ramps shall be provided to facilitate drum and equipment handling over bund walls.

3.7.5.5.3 Storage space for chemicals / lubricants

Adequate storage space for a minimum of 30 days consumption shall be provided to store the chemicals, lubricants etc at the platform.


Also area shall be identified for parking the hydraulic maintenance lift tables.


3.7.5.6 Equipment Condition Monitoring :


All critical items of equipment such as major Pumps, all Compressors, Gas Turbines and motor larger than 150 kW shall be equipped with condition monitoring instrumentation consistent with accepted industrial norms and the philosophy stated below:


- Where an equipment item is not having a standby and where its operation is critical to the running of the plant, or of the safety systems associated with the plant, continuous condition monitoring system with a provision for monitoring at Control Room, shall be provided.
- Where an equipment item is having a standby but its operation is still critical to the running of the plant, or of the safety systems associated with the plant, facilities shall be made available for local condition monitoring of the equipment. This may be in the form of


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		<p>location on the shaft or bearing housing where contact vibration and temperature measurements can be taken. Where access to these locations is not readily available, instrumentation shall be installed in a local panel to allow surveillance and/ or fault diagnostic capability.</p> <ul style="list-style-type: none"> Where an equipment item is not critical to the running of the plant, or of the safety systems associated with the plant, condition monitoring is only required on drivers over 150 kW. Locations on the shaft or housing shall be provided on this equipment to allow contact vibration and temperature measurements to be taken. Where failure of the machinery would lead to expensive repairs being required, additional condition monitoring devices shall be fitted to aid in the prevention of catastrophic breakdown. <p>For critical items like Main injection pumps(MIP's), Booster Pumps (if provided), Sea Water Lift Pumps, Gas compressor and Gas Turbine etc the alarm and shutdown signals along with critical process parameters shall be linked with Distributed Control Systems and available for action at the control room.</p> <p>The vibration monitoring system shall be Bentley Nevada system 1 or equivalent for Process gas Compressor, Gas Turbine, Gas Turbine Generators and other critical equipments. For other equipment, suitable vibration monitoring system shall be provided to ensure safe operation of the equipment.</p> <p>All condition monitoring facilities shall meet the requirements of API 670, and relevant equipment API code. Any continuous condition monitoring shall be connected to Distributed Control System (DCS).</p>		
3.7.5.7	Vibration control			
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	<p>On critical equipments like Process Gas Compressor, Gas Turbine Generators the contractor shall be required to carry out dynamic analysis including lateral and torsion analysis for the full equipment train. The minimum acceptable vibration levels for equipment are detailed within applicable governing API codes referenced herein and the Functional Specifications for vibration-5004.</p> <p>3.7.5.8 Noise limits</p> <p>Area noise limits are detailed in Functional Safety Specification 5102 and Functional Specification for equipment noise limit- 5002. Equipment noise limits shall be established to ensure the Area Noise limitations are not exceeded. In order to meet the overall noise limits for the areas specified, it may be necessary to specify lower noise limits on individual equipment. The contractor shall review the cumulative effect of individual equipment in each area of operation and shall need to ensure the overall levels specified elsewhere in the bid are within limits.</p> <p>Consideration of acoustic performance shall be given at the early stage of equipment selection.</p> <p>3.7.6 MAJOR EQUIPMENTS</p> <p>All the major equipments detailed below shall conform to the relevant API standards and functional specifications listed in this mechanical design criteria .The Functional specifications are enclosed with the bid document. These equipments shall be designed to meet the operating parameters requirement as per the process scope of work & design criteria.</p> <p>3.7.6.1 PROCESS GAS COMPRESSOR</p> <p>The process gas compressor shall be centrifugal compressor that shall conform to the requirements of API-617 and Functional Specification no. 5404F. The process gas compressor shall be driven by turbine, meeting the requirement of clause 3.7.5.8.2 of this document.</p> <p>The method for shaft sealing at casings shall be by use of Dry gas seals. Refer functional specification no 5404F as regards acceptability & experience criteria for dry gas seals. Further vendor to ensure that seal gas</p>			
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<p>shall meet seal manufacturer's quality requirements. Intercoolers and after coolers shall be air cooled type.</p> <p>The vendor shall be required to demonstrate a dynamically stable rotor system by performing lateral and torsion analyses on the compressor/gearbox/drive train across the operating range. Rotor natural frequencies that fall within 10% of operating speeds are not acceptable.</p> <p>Anti-surge protection shall be by a high integrity fast acting proven system for each compression module. The contractor shall ensure that the vendor of the surge controller shall be responsible for total anti-surge protection system, including controller, control algorithm, recirculation valves and its actuation control system. The anti-surge protection system shall act independently from other compression train control system.</p> <p>The Process gas Compressor control shall be achieved by varying the speed of the turbine.</p> <p>Compressors, Turbines and gearbox shall be mounted on a common base plate complete with oil drip pan. Depending on the contractor's recommendations compressors, turbine and gearboxes may be mounted on individual sub bases that are assembled to main unit base plate. The main unit base plate shall have provision for either three-point mounting or be suitable for mounting directly onto the main platform deck beams.</p> <p>Performance tests, to establish guarantees have been met, shall be carried out individually on compressors, drivers, and gearboxes, oil supply systems and control systems.</p> <p>3.7.6.2 GAS TURBINE DRIVERS FOR GENERATORS AND COMPRESSORS</p> <p>Gas Turbines shall be of the industrial or aero-derivative type designed, fabricated, inspected and tested in accordance with API-616 and functional specification for Gas Turbine - 5501F</p> <p>For the purpose of determining developed power the site design environmental conditions at the air intake shall be 36.7°C (98°F) and 90%RH.</p>				
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		<p>The minimum continuous ratings of the drivers shall be 105% of the power required when the compressors are operating at rated conditions. This shall allow for:</p> <ul style="list-style-type: none"> • Blade fouling and age performance degradation (4%) • Dirty inlet filters (1%) <p>Air intake filters shall be of high efficiency multi-stage type designed for low maintenance operation in polluted salt laden environment. Metallic parts shall be manufactured from type 316L S.S. Filters shall be supplied from vendor who are able to demonstrate proven designs in similar operating environments.</p> <p>Turbine vendor shall be required to provide an “off-line/online” detergent washing system. A minimum period of six months operation shall be required between “off-line” washing periods. The contractor shall be required to provide a program of “on-line” and “off-line” washing that shall ensure this requirement is met.</p> <p>Turbine shall be enclosed in an acoustic and fire resistant enclosure that has flood type fire extinguishing system that is monitored by a fire and gas detection system. Compressors and gearboxes shall preferably be open to avoid gas build-up.</p> <p>A primary fuel gas conditioning package shall be included on the platform. Dedicated secondary fuel gas conditioning system shall be included as part of the scope of each turbine package vendor.</p> <p>Dedicated Fuel gas skid shall be designed as per requirements of turbine manufacturer by treating the Fuel Gas received from Primary Fuel Gas conditioning Skid to the extent required to make it suitable as fuel for Turbine. Dedicated FGC is in Gas Turbine vendor scope.</p> <p>Lateral and torsional analysis shall be carried out for each equipment train fitted with a turbine drive. Rotor natural frequencies that fall within 10% of operating speeds are not acceptable.</p> <p>3.7.6.3 MOTOR DRIVEN COMPRESSORS:</p> <p>Motor driven compressors shall be centrifugal/screw compressors/reciprocating meeting the requirements of API-617/ API-</p>		
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	<p>619/API-618. The detailed requirement shall be as per functional specification 5410F/5401/5105.</p> <p>3.7.6.4 GAS DEHYDRATION UNIT (GDU):</p> <p>A system for the dehydration of process gas, meeting process requirement as defined elsewhere in the bid package (process scope of work & process datasheet, design criteria & P&ID's) is to be installed. Each GDU shall contain</p> <ul style="list-style-type: none"> • Gas – Glycol contactor • A complete regeneration unit packaged onto a common base plate. <p>To ensure that process guarantees are met the gas contactor and the regeneration package shall be supplied from the vendor who has single point responsibility. Glycol recirculation pump shall be electric motor driven positive displacement pump meeting either API-674/676 requirement. The requirement of GDU is indicated in detail in functional specification No: 5801 for gas dehydration package attached elsewhere in the bid.</p> <p>3.7.6.5 PRIMARY FUEL GAS TREATMENT PACKAGE:</p> <p>Fuel gas treatment package shall consist of gas scrubber, pre-heater, filters and super heaters, complete with all instruments control and piping system. It shall provide minimum 20 degrees centigrade superheat unless specified elsewhere. It shall have 99% removal of all particles greater than 10 microns and 95% removal of all particles greater than 5 microns. Further Fuel Gas shall be conditioned for the gas turbines and other equipment in accordance with the recommendations of the gas turbine vendor and respective equipment manufacturers.</p> <p>3.7.6.6 HOT OIL PACKAGE & WASTE HEAT RECOVERY UNIT (WHRU):</p> <p>Waste heat recovery exchangers (WHRE) shall be installed in the exhaust streams of turbine drives to provide processes on platforms with a source of heat. Unless specifically specified the WHRU's shall be located at exhaust of Gas turbines .</p> <p>WHRU shall meet the requirement of TEMA, ASME and API.</p>			
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		<p>The WHRU shall consist of the WHRE, Main and bypass turbine exhaust stacks, isolation louver or diverter valves (or a damper in each duct) and all ancillary equipment required for meeting the design and environmental conditions. The WHRU shall incorporate the interconnecting ducting between gas turbine exhaust duct and damper valve inlet flange and include the exhaust silencer.</p> <p>A control system for modulating the dampers shall be included. Dampers shall be actuated either pneumatically or electrically. Positive means shall be provided to prevent simultaneous closure of the dampers. Dampers shall be monitored using position transmitters.</p> <p>Hot oil package shall include an expansion tank, two circulating pumps (1+1), make up pump, filter and a hot oil dump cooler together with interconnecting piping. Hot oil pumps shall be electric motor driven centrifugal pump with mechanical seal.</p> <p>External Insulation and guarding for personnel protection shall be provided. Provisions shall be made in the Exchanger Product design and construction to facilitate ease of cleaning and tube replacement, if required. The coil bundle shall be free draining.</p> <p>Alternate proven design may be offered for company consideration.</p> <p>3.7.6.7 DIESEL ENGINE:</p> <p>Diesel Engines shall be designed, manufactured, inspected and tested in accordance with ISO-3046(latest edition) and shall meet the requirements of functional specification 5502F. Further specification 5206F (Functional Specification for Fire Water Pump) and specification 5301F (Functional Specification for Deck crane) shall be referred for equipment specific requirements of diesel engines.</p> <p>No engine shall be installed in a Zone 0 area. Wherever possible, engines should not be installed in hazardous areas. However, Engines installed in Hazardous area shall comply with EEMUA 107. Irrespective of classification area, engines used for Fire water pump and Deck Crane application shall comply with the EEMUA 107. Air intakes shall be located in a non-hazardous area. Exhaust manifolds shall be water-cooled or water-jacketed. The exhaust stacks shall be piped to the open spaces at the perimeter of the</p>		
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	<p>platform deck. Exhaust designs shall provide for rain and water protection, and shall ensure exhaust gases are not re-circulated back to air intakes or deck spaces. Exhaust stacks shall also meet the design life requirement of the platform.</p> <p>Diesel drives for fire water pump/EDG/Crane shall be equipped with two different independent means of starting:</p> <ol style="list-style-type: none"> 1. A pneumatic system that shall include a dedicated air receiver fitted with two pressure safety valves on a (1+1) sparing basis. 2. A hydraulic system completes with a charge accumulator, auto charge facility, and manual pump over-ride and control system. <p>3.7.6.8 CENTRIFUGAL PUMPS:</p> <p>Pump shall be designed, manufactured, inspected and tested in accordance with API 610(latest edition). The general requirements of centrifugal pumps are detailed in functional specification for centrifugal pump 5001F. The NPSHA shall exceed NPSHR by at least 1.0 metre based on water across the entire operating range, from minimum continuous flow to 125% of the rated capacity</p> <p>Pumps and drivers shall be mounted on a common heavy-duty base plate. A (1+1) sparing philosophy is to be used for critical applications .The complete package shall be tested for performance guarantee (full load). Where practical, Y-type or basket type suction strainers are to be installed in the upstream piping line of the pump. Strainers are to be installed at least four pipe diameters away from the pump inlet to avoid problems related to uneven flow. Suction reducers shall be eccentric, flat on top.</p> <p>Pump nozzle must not be used as anchor points for piping.</p> <p>Check valves are to be installed on all pump discharge.</p> <p>Pump auxiliary piping, mechanical seals system, vents, drains, etc, up to and including DN 25 mm shall be in 316L S.S tubing.</p> <p>3.7.6.9 MAIN INJECTION PUMP:</p>			
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Electric motor driven Main Injection Pumps (MIP) shall be provided in optimum configuration with a provision of a standby fully meeting operating parameter requirements of treated water injection as per Process Design Criteria. The MIPs shall be accommodated in suitable location at deck layout in order to comply with all process requirements and interconnecting piping with other equipments of water injection module with consideration and provision for ease of maintenance and operability, easy removal and shifting to material handling area through provision of electrically operated monorails all around.

An automatic recirculation valve for minimum flow protection of pump with built in minimum flow sensing and check valves for automatic opening to re-circulate flow at pump minimum flow. Pump design utilizing hydrodynamic bearings shall have lube oil system complying with API 614.


The auxiliary lube oil pump shall be of the same size as main pump and shall be AC motor driven. An emergency DC motor driven pump shall also be provided. The twin full flow lube oil filters shall be furnished with continuous flow transfer valves and differential pressure indicator with a switch for alarm. Lube oil shall be cooled with an air fin type cooler. As a minimum the local gauge board shall contain pump suction and discharge pressure indicators, lube oil filter differential pressure indicator, lube oil header pressure and temperature indicator, lube oil temperature indicator (after cooler).Local skid instrumentation shall also include bearing oil temperature indicators in the oil return piping at all bearings for pump and motor, oil reservoirs temperature and level indicators.

The local control panel shall contain as a minimum power supply isolation switch, selector switch remote/local operation, push buttons for start/stop of drain oil pump/auxiliary lube oil pump/emergency lube oil pump, ammeters for motors above 4kw.

As a minimum the following alarms/shutdowns shall be provided:

Function	Pre-alarm	Alarm with shutdown
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	High Lube Oil Temperature	X	X	
	Low Lube Oil Pressure	X	X	
	High Lube Oil Differential Pressure	X	-	
	Low Lube Oil level in reservoir	X	-	
	High pump radial bearing. Temperature	X	X	
	High pump thrust bearing. Temperature	X	X	
	High motor bearing. Temperature	X	X	
	High pump casing vibration	X	X	
	High vibration motor bearing.	X	X	
	High motor winding and cooling air temperature	X	X	
	Shaft axial displacement	X	X	
	High mechanical seal leakage	X	X	
	Aux. Lube oil pump running/stop	Lamp	-	
	Main Lube oil pump running/stop	Lamp	-	
	DC lube oil pump running/stop	Lamp	-	
	Selector switch positions at local/remote	Lamp	-	
	Lube oil fan motor running	Lamp	-	

3.7.6.10

FIRE WATER PUMP


Fire water pump shall be a vertical caisson type pump complying with the requirement of Functional Specification 5206 and NFPA 20. Line shaft Bearings lubrication shall be as per NFPA-20. The Pump shall be UL or equivalent certified and certification stamp to be placed on the pump/name plate as evidence of certificate for meeting the specification.


The pump shall be driven by diesel engine as per 3.7.5.8.7 and must be located in low risk area where its operation cannot be impaired by any single incident.


Pumps shall have columns and shafts limited in length to facilitate ease of maintenance during dismantling. Maintenance lift requirement must be determined as part of the maintenance philosophy & lifting study and all constraints determined shall be passed on to the vendor by contractor.

Sufficient Maintenance area shall be provided near the pump to place the pulled out shaft segments at the time of overhaul.

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	<p>Line shaft Bearings lubrication shall be as per NFPA20. The engine with gear box shall be contained in an enclosure or dedicated room and shall be provided with its own fire water suppression and automatic detection system.</p> <p>3.7.6.11 SEA WATER LIFT PUMP</p> <p>The pump shall be vertical shaft type complying with the requirement of Functional specification 5001. The pump shall be motor driven, pumping raw seawater into de-oxygenation towers through filter. Line shaft bearing shall be self-lubricating type; bearing material shall be suitable for dry running during start-up.</p> <p>Pumps shall have columns and shafts limited in length to facilitate ease of maintenance during dismantling. Maintenance lift requirement must be determined as part of the maintenance philosophy & lifting study and all constraints determined shall be passed on to the vendor by contractor.</p> <p>Vendor shall provide alarm and shutdown signals for High vibration (Motor and pump), High temperature (Motor bearing & motor winding) and high motor amperage. The pump suction shall be from 30M below chart datum.</p> <p>3.7.6.12 PROCESS PUMP</p> <p>Process hydrocarbon pump shall be designed, fabricated, inspected and tested in accordance with relevant API standard.</p> <p>Pumps shall be provided with appropriate mechanical seals based on API 682. Tandem seals with a seal leak detection system shall be fitted to all pumps pumping fluids that are above their flash points.</p> <p>3.7.6.13 UTILITY SEA WATER LIFT PUMP</p> <p>The utility pump shall be vertical submersible type designed for continuous duty. The liquid handled shall be raw sea water. The pump and motor set shall operate fully submerged in the sea water. The pump shall be as per</p>			
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	<p>manufacturer's standard, designed in accordance with the Hydraulic Institute standard. Maintenance lift requirement must be determined as part of the maintenance philosophy.</p> <p>3.7.6.14 POSITIVE DISPLACEMENT PUMP</p> <p>3.7.6.14.1 Transfer Pump</p> <p>Transfer pumps shall be electric motor / gas / air driven, as the case may be. Chemical/Diesel transfer pumps shall be in accordance with API-674, API-676, ANSI-LC-6 (for Natural Gas operated Double Diaphragm Pumps-NGODD) & ANSI/HI 10.1 - 10.5; ANSI/HI -10.6 (for Air Operated Double Diaphragm Pumps-AODD) (latest edition). Refer Functional specifications 5086F/5205/5055F for further details.</p> <p>Crude Condensate Transfer Pumps shall be in accordance to API-674 (latest edition).</p> <p>3.7.6.14.2 Control Volume Reciprocating Pump</p> <p>These pumps shall be used for chemical dosing applications including injection of chemical corrosion inhibitors in the well fluid departing lines. Pump under this application shall meet API 675 (latest edition) requirements.</p> <p>Pressure relief valve shall be provided for transfer as well as Control Volume reciprocating pump. Refer Functional specification 5055C for further details.</p> <p>3.7.6.14.3 Rotary Gear Pumps/Screw Pump</p> <p>The pump shall be designed, manufactured, inspected and tested in accordance with API-676 and relevant functional specification no 5086F. Pressure relief valve shall be provided with each pump. The pump shall be used for diesel and chemical transfer.</p> <p>3.7.6.15 IA/UA COMPRESSOR PACKAGE</p> <p>Instrument & Utility Air compressor package shall be provided to meet the instrument air requirement of instruments control and other utilities of platform equipment. An air dryer package shall also be provided on each</p>			
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platform. The compressor shall be driven by electric motor / Diesel Engine as specified. For details, refer functional specification of Instrument & Utility Air Compressor package with air dryer (Spec. No. 5402)

3.7.6.16 INERT GAS GENERATOR

Inert gas generator shall be provided to meet all the utility requirement of the platform. For details, refer functional specification of Inert gas generator (Spec. No. 5903F and 5907)

3.7.6.17 POT WATER PUMP

Pot water pump shall be electrical motor driven centrifugal pump with mechanical seals.

3.7.6.18 MATERIAL HANDLING FACILITIES

The material handling facilities envisaged as a minimum, have been indicated in SECTION 2 Description of work of the bid document. Material handling facilities study shall be carried out by contractor during detailed engineering stage based on the equipment sizes and weight selected and it shall be reviewed / approved by Company and incorporated by the contractor. Actual requirement shall be established based on this study and the facilities shall be provided accordingly, without any extra cost to the Company.


Necessary hooks/Beam clamps shall be provided in the process areas and above all such maintenance prone equipment where material handling facilities are not permanently located or deck crane access is not available.


All equipment supplied for material handling including lifting points and beams shall be identified with its applicable safe working load and shall be certified for that.


Adequate Material Handling facilities shall be provided on the platform for the following:


i) Handling and transfer of equipment assemblies / subassemblies/ spare parts during routine maintenance.


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	<p>ii) Handling and transfer of equipments, materials, (to and from lay down areas) consumables like chemical drums, lubricants etc. from Boat landing/ Supply vessel/ Barges to respective areas/locations , with most convenient manner requiring minimum handling time.</p> <p>iii) Movement of operating personnel through personnel baskets in case of emergency.</p> <p>iv) Lay down areas shall be provided on platform decks for handling and transfer of equipment, material, chemical drums etc from and to supply vessel / barges</p> <p>v) Access hatches shall be provided on platform decks for handling and transfer of equipment, material, chemical drums etc from one deck to another deck. Areas above and below the hatches shall be clear of piping, cabling, supports etc to allow unobstructed lifting of equipments.</p> <p>vi) A Detailed drawing indicating all material handling facilities shall be provided for company's review.</p> <p>Material Handling facilities are broadly categorized as:</p> <ul style="list-style-type: none"> a) Pedestal Mounted Diesel Engine Operated Deck Crane b) Traveling Bridge crane c) Electrically operated monorail hoists d) Jib Cranes e) Manually operated, trolley mounted / Hook mounted chain pulley blocks f) Portable Trolleys g) Easily maneuverable, portable hydraulic maintenance lift tables. <p>The following material handling philosophy shall be considered:</p> <ul style="list-style-type: none"> • Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where weight exceeds 15 kg. 			
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		<ul style="list-style-type: none"> Equipments/ parts between 15-500 kg can be handled using portable (temporary) lifting/handling equipment such as trolley, beam clamps, chain pulley blocks etc. Equipments/ parts heavier than 500 kg shall be handled by permanent provision of lifting lugs, trolley, hoist etc. Manual hoist with geared trolley will be provided for areas with equipment/ Component to be lifted for erection and maintenance weighing up to 2 MT and below and lift is less than 5 m. Electric operated monorail hoist will be provided for areas with equipment/ Component to be lifted for erection and maintenance weighing more than 2 MT and/or lift is more than 5 m. The hoist shall comply with the prevailing national/international codes. Electrically operated monorail hoists / Travelling Bridge crane shall be provided in the area where the weight of the heaviest component exceeds 5 MT and movement of the components will be required in both transverse and longitudinal direction. Particular attention shall be paid to handling of equipment located at higher elevations like safety valves. <p>Electric hoists shall comply with standards IS-3938 or BS: 4465 or any equivalent Specification for design and construction of electric hoists.</p> <p>3.7.6.18.1 Pedestal Mounted Diesel Engine operated Deck Crane:</p> <p>The crane shall be mounted on main deck, and designed, fabricated, inspected and tested in accordance with the requirements of API 2C and Functional specification for deck crane- 5301F.</p> <p>The quantity and capacity of crane shall be as specified in Section 2 Description of work and decided on following conditions:-</p> <p>a) The crane shall be capable of lifting a minimum load (dynamic capacity), as specified in the description of work, from the supply vessel.</p>		
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		<p>b) Crane shall be capable of lifting minimum load (static capacity) for performing various operations on platform including farthest point/farthest conceived as future facilities.</p> <p>c) Deck cranes of required capacity and required boom length (boom length shall be selected that it shall cover entire platform area including future facilities) computed in accordance with API 2C shall be provided by the Contractor. The boom length shall be so decided that it shall cover the entire process platform including future facilities and loads needed to be lifted at appropriate locations for maintenance / material transfer.</p> <p>d) Boom rest (fixed type) shall be provided at convenient locations on deck complying with crane vendor's recommendations. With boom resting on boom rest, the hook or wire rope shall not touch the platform deck.</p> <p>e) The crane shall be such located that the boom shall be capable of handling consignment at helideck level as well as from boat landing area to lay down areas on deck. The boom shall be capable of rotating 360 degrees with lift load.</p> <p>f) Access platforms with hand rails shall be provided for ease of maintenance of various items such as boom sheaves, sheave on top of gantry, slew mechanism underneath, winches etc.</p> <p>g) The crane shall be installed in such a manner that the requirements given in API RP 2L (Heliports for fixed offshore platform, latest edition) with regard to flight deck approach / departure are met and it shall not interfere with helicopter operation. Helicopter shall have clear approach/departure from all directions.</p> <p>h) Care shall be taken to ensure operators safety, smooth maneuverability inside cabin, all around visibility, ease of access and approach for maintenance and safety interlock features as detailed in Functional specification / data sheets.</p> <p>i) In case the vendor offers a design where the hydraulic circuit which governs the movement of crane, utilizes solenoid valves the provision/arrangement shall be made by vendor for a backup to the</p>		
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<p>power supply for operations of these solenoid valves and alarms and shutdown signals if any.</p> <p>j) Adequate space shall be provided, to carry out maintenance and repair of engine sub-assemblies, cylinder head, radiator assembly etc inside engine enclosure. However space shall not be less than 750 mm all around the engine.</p> <p>k) With boom in highest position, the wire rope length selected shall be such that hook is able to reach chart datum (sea level), still keeping at least one full layer of the unused rope on the rope drum.</p> <p>l) Turbine and engine exhaust shall be directed away from the platform in safe location in a manner that the operation of deck crane and working in operator's cabin is not affected.</p> <p>m) The primary power for crane operation shall be provided by diesel engine equipped with starting systems as per specification.</p> <p>n) Elevation of deck crane pedestal shall be decided to provide vision for loading & unloading from supply vessel/ barge/ boat landing area to loading/unloading laydown areas on decks.</p> <p>Deck crane shall be capable for:-</p> <ul style="list-style-type: none"> - Lifts from supply boats / vessels & barges etc and certified for transfer of personnel through personnel baskets (in case of emergency) by auxiliary hook from Boat Landing/Supply Vessels / Barges at appropriate locations on decks - Minimizing blind lifts - Reduced risk of dropped objects on live hydrocarbon equipment - Access to lower decks through use of lay down areas or access hatches <p>3.7.6.18.2 Traveling Bridge Crane</p> <p>Traveling bridge crane(s) of appropriate capacity to facilitate means of dismantling compressors, gear boxes and other auxiliary components and transporting them to module maintenance area / platform lay down area to be provided. The lifting equipment shall have an electrical lifting arrangement</p>				
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<p>with provision for inching speed and electric motor operated travel in both transverse and longitudinal direction.</p> <p>3.7.6.18.3 Electrically operated Monorail Hoists</p> <p>Adequate numbers of electrically operated monorail hoists shall be provided for access and maintenance of all heavy equipment sub-assemblies installed on the platform like Main injection pumps, HVAC systems, Emergency generator assemblies, IA/UA compressor package, Fire water pumps, Turbine generator, Sea water lift pumps etc.</p> <p>These hoists shall also be able to move items to lay down area. It shall also be provided on the interconnecting bridges for transfer of material between platforms.</p> <p>The equipment supplied shall include monorail hoist with drive motors, flexible power supply cable with support rail, pendant type push button, control panel, limit switches, brakes etc.</p> <p>All hoists shall be preferably of low headroom type.</p> <p>All hoists shall be suitable for electrically hazardous area.</p> <p>Load test shall be carried out at vendors work, fabrication yard and at offshore. Load test at 125% of safe working load shall be carried out in presence of company / its authorized representative or certifying agency. Electric hoists shall comply with standards IS-3938 or BS: 4465 Specification or DIN 15020 or any equivalent specification for design and construction of electric hoists.</p> <p>3.7.6.18.4 Trolley Mounted/ Hook Mounted Chain pulley Blocks</p> <p>Adequate numbers of trolley mounted chain pulley blocks (manually operated) shall be provided to facilitate maintenance of Instrument /utility air compressor, fuel gas conditioner, pig launcher etc on the cellar deck and sump caisson pump at jacket level. The capacity shall be sized to enable lifting of major sub-assemblies like casing/motor.</p>				
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<p>Additionally , hook mounted Chain Pulley blocks of adequate capacity and number shall be provided (as indicated in section- 2 ;Description of work and finalized during detailed engineering) as store item for use during repair and handling of platform equipment which are otherwise not serviceable by other material handling facilities.</p> <p>Chain pulley blocks shall be suitable for operating in electrically hazardous area and shall be constructed from non-sparking materials and comply with standards IS-3832 or BS: 3243 or BSEN 13157 Specification for hand operated chain blocks. As a minimum requirement the Chain Pulley blocks shall be ISI marked or equivalent and shall be designed & manufactured in accordance to the relevant standard.</p> <p>These chain pulley blocks shall be suitable for deployment in marine atmosphere (to be installed on offshore platform).</p> <p>Necessary Hooks / Beam clamps shall be provided in the process area for mounting of chain pulley blocks.</p> <p>3.7.6.18.5 Hydraulic (Easily maneuverable) maintenance lift tables:</p> <p>Hydraulic maintenance lift shall be a complete unit comprising of portable hydraulically movable platform, electric motor driven hydraulic power pack, cable reels and limit switches, local control panel with motor starter etc.</p> <p>Control shall be provided on the working platform for lifting / lowering smoothly, fixation at any place and also for inching operation. Also, provision shall be made for emergency lowering from base. Controls shall also facilitate fixation of platform in any intermediate position. Limit switches shall be provided on highest and lowest positions of platform. Load test at 150% of safe working load on platform shall be carried out.</p> <p>Parking location of Hydraulic maintenance lift tables shall be marked on deck layout drawings.</p> <p>The quantity, Lifting capacity, Height of lift and platform size shall be as specified in Section 2.3.7 - Description of work. The maximum maintenance height required shall govern the lift of maintenance table.</p>				
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3.7.6.18.6 Diesel Engine operated Pillar Jib Crane

The Jib crane shall have following particulars:-

Capacity	: As indicated in the description of works
Boom Length	: To be decided during detail engineering
Lift	: Materials are to be lifted from supply boat
Hoisting speed	: as per API-2C (Refer FS-5301F).
Slew speed	: 0.5 rpm (indicative)
Dynamic load calculation:	As per API 2C

Typical loads which are to be lifted are nitrogen cylinder banks, chemical drums and maintenance equipment/ spares/ sub-assemblies etc up to weight specified in the description of work from supply vessels/boats etc.

The slewing of the jib will have its envelope free from any obstruction. No deck piping and vertical interferences will be allowed in this envelope. Crane shall have adequate boom length to handle loads at boat landing area. The Jib crane shall have Hoist, Trolley and Slew motions.


The hoist, trolley & slew motion shall be operated hydraulically. Separate hydraulic pumps shall be provided for each of the following functions – Hoist, Travel & slewing. Suitably sized hydraulic reservoir, filters, relief valves and finned air cooler shall be provided. Drip pan shall be provided below hydraulic system components.


The hydraulic oil selected shall be suitable for duty temperature corresponding to extreme ambient conditions.


The slewing circle shall consists of slewing ring bearing with integral swing gear of gear and pinion type and flange for mounting it on the column / mast / pillar. Swing mechanism shall be provided with mechanical positive lock arrangement controllable by the operator. Chain drive shall not be acceptable for crane swing system.


Crane shall be self-supported type with 360° swivel.


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3.7.6.19	<p>PRESSURE VESSEL</p> <p>All pressure vessels shall be designed and engineered in accordance with ASME Section VIII, Div.1 and shall have “U” Code stamping except for Glycol Seal pot.</p> <p>Vessel size, wherever indicated on job specification/data sheets or elsewhere are indicative. Contractor shall perform all calculations and verify the sizes and provide adequate size of vessels. Any deviation from the data sheet will require specific approval from the Company.</p> <p>Basic features shall be as follows:</p> <ul style="list-style-type: none"> ▪ All nozzles shall be welded and flanged. ▪ Minimum manholes size shall be DN 500 unless restricted by vessel diameter. Covers shall be equipped with swinging type davits. ▪ Vessel shall have 750 MM wide platform at all manholes and at any other identified maintenance location. ▪ Vessels shall be provided with temporary sea fasteners as required ▪ To ensure proper fit, level indication and instrumentation directly attached to the vessel shall be included in the scope of vessel vendor. ▪ For clad vessels, cladding thickness shall be minimum 3 mm. <p>Davit shall be provided for all pressure vessel man ways.</p> <p>The general requirements for pressure vessels are as detailed in functional specification for unfired pressure vessel 5601.</p> <p>The contractor shall develop specifications for vessels for gas services, liquid / chemical services, Instrument / utility systems.</p> <p>3.7.6.20 TANKS</p> <p>Tanks shall be designed, manufactured and tested, in general, in accordance with API 650 (modified to suit rectangular tanks for offshore duties) or Roark’s formula.</p> <p>Basic tank features shall be as follows:</p> <ul style="list-style-type: none"> • Tanks shall be provided complete with supports, nozzles and openings with appropriately rated flanges, lifting lugs, ladders and 			
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		<p>platforms. Level indication and instrumentation directly attached to the tank should be included as part of the Tank contractor's scope.</p> <ul style="list-style-type: none"> • The tank shell to roof and shell to bottom shall be butt – welded. Adequate stiffeners shall be provided to prevent buckling of tanks under the hydrostatic head and to ensure mechanical stability. • Inspection hatches with minimum size of 500 mm DN shall be provided on tank roofs in accessible positions and shall be provided complete with blind flange, bolting, gaskets etc. • All tank openings shall be flanged. Minimum nozzle connection size shall be 50 mm (2") DN • Depending on the tank height internal / external access ladder shall be provided. • Tanks containing volatile fluids shall be vented to safe areas • Tanks shall generally have floors sloping towards drain nozzle. • Tanks shall be adequately supported on a rigid base that provides a clear gap between tank bottom and platform deck to facilitate washing down and avoid accumulation of water. • Materials and appropriate internal and external surface protection coatings shall be specified by vendor. Grade 316 L SS shall be used for water storage tanks and lubrication oil tanks. Where tanks are required for sour service, the additional requirement of NACE MR 0175 shall apply. • The corrosion allowance for carbon steel tanks shall be at least 3mm. No allowance is required on S.S tanks 		
	3.7.6.21 HEAT EXCHANGERS			
	3.7.6.21.1 Shell and Tube Heat Exchangers			
		<p>Shell and tube heat exchangers shall be designed, fabricated, inspected and tested in accordance with API 660, TEMA class R and ASME section VIII Division 1. Each exchanger shall be analyzed for conditions of internal design pressure, external design pressure, maximum and minimum design temperatures, corrosion allowance, etc in accordance with the process function. The flow of corrosive or high fouling fluids shall be restricted to the tube side of exchangers. Vendor shall be responsible for thermal and mechanical design and for obtaining ASME code Stamping. The thermal design and rating of shell and tube heat exchangers shall be based on</p>		
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		<p>design methods which have been proven in practice. In this respect, the design procedures and computer programs published by the Heat Transfer Research Institute (HTRI), and those published by the Heat Transfer & Fluid Flow Service (HTFS), are considered proven design methods.</p> <p>Shell diameters should be limited to 1500mm DN. Tube diameters & wall thicknesses should conform to TEMA preferred values. Straight tube lengths shall be limited to 6100mm.</p> <p>Shell and tube exchangers with bonnet type channels shall have full diameter tube sheets and collar bolts. Channels, channel cover and bonnets shall be fitted with lifting lugs.</p> <p>All heat exchangers connections shall be flanged according to ASME B 16.5, minimum nozzle size 50mm DN. Piping shall be ASME B 31.3. U-tubes shall have a minimum bend radius of 1.5 times the tube outside diameter and shall be heat treated where the extreme fiber strain exceeds 5%. Bundle runners shall be fitted to all removable bundles.</p> <p>The requirement for shell and tube heat exchangers is detailed in the functional specifications 5702F.</p> <p>3.7.6.21.2 Air Cooled Heat Exchangers</p> <p>Fin-fan-air cooled heat exchangers shall be designed, fabricated, inspected and tested in accordance with API 661. Pressure-retaining components (headers) shall comply with ASME VIII Appendix 13. Pressure piping within package shall be designed and fabricated to ASME B 31.3.</p> <p>Vendor shall be responsible for thermal and mechanical design and for obtaining ASME code Stamping. The thermal design and rating of an air-cooled heat exchanger shall be based on design methods which have been proven in practice. In this respect, the design procedures and computer programs developed by HTFS and developed by HTRI are considered proven design methods. The print-out of the computer runs shall correspond to the input data</p> <p>The requirement of air-cooled heat exchanger is detailed in functional specification no 5701F.</p>		
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	<p>3.7.6.22 SOLUTION TANKS AND MIXERS:</p> <p>The solution tank and mixer skid shall consist of small electric motor driven pump package for fully meeting the intended functional requirements of Solution Tank and Mixtures.</p> <p>3.7.6.23 DIESEL FILTER / COALESCE</p> <p>Diesel filters / Coalesces shall be complete and operable units comprising of supports, nozzles, flanged inlet/outlet connections, drain connection, flange cover with pipe davit, filter element, relief valve, differential pressure indicator and other accessories as required. The filter shall remove solid particles / moisture content that may be present in the diesel system. Refer Process design criteria and P & ID for capacity and instrumentation requirements.</p> <p>The vessel shall be designed, fabricated and tested in accordance with ASME Section VIII Div-1 and Functional specification for unfired pressure vessel- 5601. ASME code stamp shall be provided for filter vessel. As a minimum requirement, the vessel shall be designed for spot radiography. Dish ends to shell circumferential joints shall, as a minimum requirement, be, partially radio graphed.</p> <p>Filter shall be provided with flanged cover for easy removal / replacement of filter element. Diesel filter shall be cartridge type.</p> <p>The selection criteria along with the specifications and other details for the filter elements shall be fully described in the proposal.</p> <p>3.7.6.24 DIESEL CENTRIFUGE</p> <p>Diesel centrifuge shall be designed, fabricated, inspected and tested in accordance with functional specification for Diesel centrifuge 5902F, process design criteria and P& ID.</p> <p>3.7.6.25 HEATING VENTILATION AND AIR-CONDITIONING (HVAC)</p> <p>HVAC Compressor shall be screw/reciprocating type complete with automatic capacity control. The buildings and facilities on the platform shall be provided with suitable ventilation/ air conditioning systems and wherever necessary shall be pressurized as specified. HVAC systems shall be</p>			
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designed, manufactured and tested according to ASHRAE / CARRIER/ARI/AMCA and SMACNA standards and functional specification No 5901F.

Areas shall be air-conditioned and ventilated as generally identified in Section-2 Description of work in bid document and approved by company during post order stage.

90/10 Cu-Ni pipe/Cu pipe and fittings shall be used for refrigerant piping.

Contractor to supply HVAC load estimates prior to fabrication for ONGC reviews and acceptance.

3.7.6.25.1 Ambient / Inside Design Condition

The design basis of HVAC equipment shall be based on site conditions indicated elsewhere in the bid document.

Room Temperature and Humidity Conditions to be achieved by HVAC system shall be as indicated in Section 2 Description of Work of bid document.

3.7.6.25.2 Pressurization Systems

All enclosed areas of the platforms that are mechanically ventilated shall be protected from ingress of potentially explosive gases by purging/pressurization.

Minimum Pressurization and alarm level shall be 50Pa (5mmWG). Alarms shall be time delayed. Gas detectors shall be provided at air inlets.


A purge cycle shall occur upon initial start up of the Pressurization System and upon any loss of pressurization.


3.7.6.25.3 Equipment design


The following equipment shall be installed with a sparing design:


	Equipment/ package	Sparing philosophy
1	Air conditioning plant	

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	1a	Chiller Package (Comprising of compressors with drivers, condensers with drives and evaporator	One (1) number complete Chiller package as working + one (1) number complete Chiller package as stand by.			
	1b	Chilled water pump with drives	One (1) number complete as working + one (1) number as stand by.			
	1c	Supply air fans inside Air handling units	Each AHU shall have one (1) number working Supply air fan with drive + One (1) number stand by Supply air fan with drive			
	2	Ventilation system				
	2a	Supply air fans with drives	One (1) number complete as working + one (1) number as stand by.			
	2b	Exhaust fans with drive	One (1) number complete as working + one (1) number as stand by.			
	<p>Refrigerant for plant shall be R134a or equivalent environment friendly.</p> <p>Fire Dampers must be utilized when a ventilation system serves more than one fire compartment or passes through a fire rated partition. The ratings of the fire dampers shall be at least that of the fire division that they penetrate. In the event of a power failure the fire dampers must fail in the closed position. Fire dampers shall be UL/FM Approved.</p>					
<p>3.7.6.26 FIRE AND GAS DETECTION SYSTEM:</p> <p>Fire and gas detection system (including portable detector (HC and H₂S) shall be provided as described in Section 2-Basic bid work- for instrumentation and relevant functional specification.</p>						
<p>3.7.6.27 ACTIVE FIRE PROTECTION</p> <p>Active fire protection system shall be to control /reduce the effects of smoke and radiation and extinguish fire on platforms.</p>						
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<p>The primary purpose of deluge systems is to cool areas and equipment that may be affected by radiated heat from a fire and prevents escalation. Deluge system shall be either locally applied as in the case of vessels or provided for general area protection to protect personnel from radiation.</p> <p>Monitor may be used to, in support of fixed fire protection systems to cool process areas and equipment that may be affected by radiated heat from a fire, provide local cooling at jet fire impingement areas on vessels and prevent escalation.</p> <p>Foam is used where there is a risk of pool fire. This includes chemical and diesel storage areas. The objective of foam systems is to extinguish pool fires. Foam may be applied via portable, monitors or hand held hoses.</p> <p>Firewater system shall be designed and installed to facilitate system and equipment testing in accordance with the requirements of NFPA25.</p> <p>3.7.6.27.1 DCP Skids with Hose Reels:</p> <p>Minimum quantity of DCP skids with hose reels is indicated in Section 2.3.7.- Description of work for Mechanical equipments. The capacity of the individual unit shall be minimum 350lbs. Based on the outcome of the QRA/ Safety studies, the unit selected must be adequate for covering the largest pool of fire. In such a case, if higher capacity of unit is required, it shall be supplied. The units shall be located at easily accessible area and hose length shall cover all points on the deck.</p> <p>For acceptance of the system full discharge test shall be carried out at each installation.</p> <p>The dry chemical skid shall include but not limited to nitrogen cylinder, chemical storage vessel, initial nitrogen and chemical charge, actuator system, necessary piping/instrument within skid battery limits. All the components shall be mounted on a common structural skid, fully assembled, piped with outlet piping terminated at the skid edge for appropriate hook-up of close coupled hose reel, wired, tested and painted for marine environment. Extra fill of dry chemical powder and nitrogen cylinder with valve and nitrogen cartridge as 100% standby also shall be supplied for each unit such that the skid can be made ready for next application. However, the standby Nitrogen cylinders for DCP skid shall be</p>				
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		<p>supplied with separate stand and shall be stored near DCP Skid. The dry chemical used in DCP shall be high grade, non – caking, potassium bicarbonate base and shall be compatible with AFFF type foams.</p> <p>Vendor shall design dry chemical container as per ASME Section VIII, Div. 1. Corrosion allowance for dry chemical container shall be minimum 3mm.</p> <p>The final acceptance criteria for this package shall be in accordance with the applicable Codes/Standards and FS 5067. The offered Dry chemical skid shall be UL listed.</p> <p>Vendor shall indicate operating pressure of system.</p> <p>3.7.6.27.2 Clean Agent System (Auto-Operated System)</p> <p>Clean agent fire suppression system shall be provided for Control rooms, Switch Gear rooms, all Electrical rooms and Battery rooms. Clean Agent Fire Suppression System shall be auto operated system. The extinguishing system shall provide a high-speed release of suppressant based upon the concept of total flooding within 10sec as per NFPA 2001. It shall be designed so that it can be activated automatically by receiving a signal. The Fire suppression system shall also be manually operable by operator in the event of a signal from any of the fire sensor devices. Manual activation and inhibition of suppressant release after activation shall be located at the exit of the enclosed area. Each area protected by suppressant shall have an adequate primary source and 100% backup supply manifold together and located outside the area. For further details refer functional specification 5103.</p> <p>3.7.6.27.3 CO₂ System</p> <p>CO₂ fire suppression system (Or Clean agent System as specified above) shall be provided for Gas Turbine enclosure. The extinguishing system shall be release of suppressant based upon the concept of total flooding within 30sec as per NFPA 12. It shall be designed so that it can be activated automatically by receiving a signal.</p> <p>The Fire suppression system shall also be manually operable by operator in the event of a signal from any of the fire sensor devices. Manual activation</p>		
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and inhibition of suppressant release after activation shall be located at the exit of the enclosed area. Each area protected by suppressant shall have an adequate primary source and 100% backup supply manifold together and located outside the area.

3.7.6.27.4 Portable fire extinguishers

Portable and wheeled fire extinguishers shall be located at strategic points around the installations to provide rapid response and easy to operate fire fighting facilities to deal with small outbreaks of fire.

The fire extinguishers selected for each location will be based on the fire hazard class present in that area


Class	Combustible Hazard	Extinguisher Type
A	Ordinary combustibles such as wood, cloth, paper, rubber, plastics etc	Water, Dry Powder
B	Flammable liquids, oils, greases, oil based paints, lacquers and flammable gases	CO2, Dry Powder
C	Electrical equipment where it is dangerous to use a Conductive medium.	Dry Powder,CO2


All portable and wheeled fire extinguishers shall be selected and located for accessibility and visibility and locations shall be clearly marked to identify the type of extinguishing and its suitability for different types of fire.

Fire extinguishers will be positioned generally such that personnel will at no time be more than 9 meters from an extinguisher, except in accommodation areas with class ‘A’ fire hazards, where the distance can be increased to 23 meters. Extinguishers will also be located within each room (excluding cabins) or enclosure, adjacent to every entrance or exit.

Supplier standard portable and wheeled fire extinguishers shall be specified with the following sizing and performance considerations:

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	<ul style="list-style-type: none"> ▪ The design, construction and testing of all types of fire extinguishers shall be specified in accordance with recognized standards. ▪ All types of fire extinguishers shall, as far as possible, have a standard and simple method of operation. ▪ Portable fire extinguisher sizes will be selected as small as practical to be effective and for ease of operator deployment. ▪ CO2 extinguisher sizes will be determined to ensure that leakage or accidental discharge will not cause a hazardous CO2 concentration. ▪ Dry powder portable and wheeled fire extinguishers shall use potassium based agents and be compatible with AFFF. <p>Dry powder extinguishers shall be fitted in the galley. Extinguishers (type and numbers) in building areas shall be as per requirements specified in relevant codes.</p> <p>CO2 extinguishers with total capacity not less than 22.5 kg shall be provided at each access point to the helicopter landing area and one of the extinguishers shall be fitted with a lance suitable for helicopter engine fires.</p> <p>Portable extinguishers located in exposed and naturally ventilated locations shall be stored in suitable weatherproof cabinets as protection from the effects of wind and rain. The cabinets will be marked and color coded in accordance with project standards.</p> <p>Trolley-mounted dry powder extinguishers shall be provided in addition to portable extinguishers for protection to all areas where the primary risk is from a liquid hydrocarbon fire. This shall include the process areas, diesel drivers and areas containing diesel, heating oils, lube oils and aviation fuel storage.</p> <p>Each extinguisher shall have a minimum capacity of 50 kg of dry powder and be supplied with nitrogen pressurization cylinders and discharge hose terminating in a control nozzle.</p>			
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<p>Trolley-mounted dry powder extinguishers shall be located at each installation level, adjacent to fire hydrants, which provides the fire team with easy access to the fire risk areas.</p> <p>All components of the fire extinguishers shall have approval of UL or equivalent certifying agency.</p> <p>The portable fire extinguishers shall be suitable for use in systems and installation designed in accordance with codes & standards.</p> <p>Portable dry chemical Fire extinguishers of UL rating 120: BC (or equivalent) and CO2 extinguishers with a UL rating of 10: BC(or equivalent) shall be provided at all strategic locations on the platform inadequate numbers (to be firmed up during detail engineering). The locations of fire extinguisher shall be readily accessible and visible as per US Coast Guard regulations and other codes. These locations shall also take into account at least one extinguisher in each of the enclosed area on the platform. Refer FS-5102 for further details. Fire extinguishers shall be ISI marked or UL/FM listed.</p> <p>These locations shall also take into account at least one extinguisher in each of the enclosed area on the platform.</p> <p>Each portable fire extinguisher shall be housed in an enclosure of weatherproof material that permits easy removal.</p> <p>3.7.6.27.5 Fire Water and Fire Suppression System</p> <p>This system will mitigate or control a fire after it has been positively identified. It may be actuated either manually or automatically. Fire Suppression System shall comprise of the following:</p> <p>Fire water Pump:</p> <p>Fire water pump shall be complete with local control panel and diesel tank as per NFPA 20 standards and Functional specification for fire water Pump 5206. The pump shall be capable of supplying a minimum quantity as specified in Section-2 Description of work.</p>				
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Deluge type fire water net work

A deluge type water spray network shall be designed in accordance with NFPA 15 and API 2030. This system shall be located over all deck areas and designed to provide water at the net rate as specified below:

Sr. no	Equipment/Area	Water rate in lpm/m2
1	Compressors, Pumps and other hydrocarbon handling equipment	20.4
2	Air fin coolers	10.2
3	Pressure Vessel and heat exchangers	10.2
4	General coverage area	4.1


This requirement shall supersede the requirement of flow as indicated in functional safety specification. Special attention shall be given to isolate fire water loop as far as possible from process lines on the pipe racks. Fire water loop shall have fusible plugs at strategic location as per requirement of governing code which will melt at 85°C. Deluge valve testing facility shall be equipped with testing facility without actuating the sprinkler system and ESD / FSD system. The flow rate indicated above (deluge system) is minimum, and if any code/ standard require more flow rate then system shall be designed accordingly.


Fire water system hydraulic calculation to be carried out during detailed engineering.


Fire Loops

A pressurized fire loop consisting of adequate size (Company approved) pressurized tubing containing requisite number of fusible metallic plugs and strategically located hand valves shall be run overhead on all equipment areas and well heads.

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		<p>The fusible plugs shall melt at 85°C (185°F) and resulting depressurization of the fire loop shall cause:</p> <ul style="list-style-type: none"> a) Audible and visual alarm b) Platform shutdown c) Opening of deluge valve in the fire spray network <p>Adequate number(s) of fixed/portable fire water and foam spray system, water and Foam Hose Reel, hydrants (Qty. to be firm'd up in Detailed Engineering) to be installed at most suitable locations.</p> <p>3.7.6.27.6 CO₂ Snuffing System</p> <p>Carbon Dioxide snuffing system shall be provided for vent boom for each platform as a fire suppression system. The equipment shall be skid mounted, automatically activated snuffing system complete with all necessary accessories to make it a complete operable unit.</p> <p>The system shall include but not be limited to pressure regulator, pressure indicator, pressure switch low, check valve and isolation valve for each cylinder. Requirement of CO₂ cylinders shall be as per NFPA 12. The system shall be designed in accordance with NFPA 12 and all mandatory requirements of NFPA-12 shall be complied. Vendor to ensure that CO₂ flow rate is sufficient to extinguish the flame and also cool the vent tip below the auto ignition temperature in case the vent tip has been ignited. The snuffing system shall be sized to extinguish the vent tip flame two in succession (two firings) when it is burning. The unit shall have an initial charge and 100 % spare charge of carbon dioxide with necessary piping, pressure switches, gauges, valves, associated controls, instrumentation required for proper operation or safety shall be furnished by the vendor and shall be completely assembled for ready operation after installation on the platform. The vendor shall standardise the capacity of cylinder for better replacement and inter-changeability. The vendor shall preferably select the capacity of cylinder keeping the filling ratios as per NFPA. The vendor shall supply CO₂ cylinders with regulators, test valves, orifices, relief valve and necessary fitting. The initial carbon dioxide (CO₂) charge shall have a moisture content of less than 0.01 per cent by weight (dew point of -30°F). Also oil content shall not be more than 10 PPM by weight. Each cylinder is to be fitted with a pressure regulator for pressure reduction and tied to a discharge line at vendor's battery limit. The</p>		
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		<p>contractor shall provide a suitable system to monitor the weight of CO2 containers as per NFPA-12. The proposed system shall have the capability</p> <p>of being recharged on the platforms. Vendor shall design the size of piping between cylinders and vent nozzles. The size and type of outlet line connecting to vent boom shall be decided as per gas flow rates. Vendor shall design and submit sizing calculations and CO2 gas requirement for snuffing the Vent boom. The Design calculation shall be certified by a third party.</p> <p>The unit shall be designed in such a manner that replacement / isolation of cylinders can be done without hampering the operability of the system. The sizing and capacity of each system shall be determined during detailed engineering phase and shall be duly approved by Company. The equipment shall be designed for outdoor location on an offshore platform with site conditions described elsewhere in the bid document. Skid equipment arrangement and piping arrangement shall be made in such a manner that tripping hazards are reduced to minimum. Also adequate protective devices shall be provided to prevent accidental discharge or activation of the system. The system shall also include access / provision / facilities for maintenance of the snuffing system.</p> <p>The equipment shall be designed, manufactured and tested as per NFPA, ASME, ASTM-A-53-88, ASTM-A-106-88, ASTM-E380 standards as a minimum.</p> <p>For acceptance of the system all tests as per NFPA-12 including full discharge test shall be carried out at each installation.</p> <p>All offered cylinders shall have current certification/approval/listed by an approved competent authority of the country of origin (FM/UL/Vds/LPC) /approval by PESO, Nagpur.</p> <p>Lifting eyes shall be provided to facilitate loading and unloading. Entire skid and components shall be coated in accordance with Functional Specification No.2005, "Protective Coating". Inspection, certification and testing modalities shall be finalized during the detail design phase.</p>		
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3.7.7

LIFE SAVING EQUIPMENT

3.7.7.1

General

The lifesaving equipment to be provided shall be as described herein and as defined in United States Coast Guard “Rules and Regulations for Artificial Island and Fixed Structures on the Outer Continental Shelf CG-320. This guideline is an excerpt from the code of Federal regulation, Chapter 1 of title 33.

The lifesaving equipment shall also meet the requirements of Statutory International Maritime Organization (IMO) and International Convention on Safety of Life at Sea (SOLAS). The equipment shall have certificates of approval of Mercantile Marine Department (MMD), Government of India or equivalent statutory authority, wherever applicable.

3.7.7.2

Life Saving Equipment-Minimum Quantity Requirement

The platform shall be equipped with the required number of life rafts, life preservers, life ring buoys, life jackets, first aid kits, stretcher, fire blanket, personal basket, and as described in bid package (Description of work) as a minimum and as per the applicable codes. However based on the safety studies any additional facilities/ quantities required shall be provided without any time & cost implications to the Company.

The number of life ring buoys shall be calculated such that a life ring buoy can be accessed within 10 m of any point on the platform.


For details refer FS 5102 (Functional safety specification)


3.7.7.3


Life Boat (Survival Craft)

The quantity and capacity of the survival craft shall be as indicated in section 2.3.7 Description of work. The craft shall be designed to meet safety

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<p>requirements as per SOLAS for personnel safety. It shall have MMD certificate of approval.</p> <p>The survival craft shall be totally enclosed type and shall be constructed from fire retardant fiber glass reinforced plastic.</p> <p>It shall be powered by suitably sized diesel engine of marine duty type. The diesel engine shall have i) hydraulic powered starting system (Engine shaft driven hydraulic pump and charged accumulator with manual pump override ii) Manual starting with hand cranking.</p> <p>Launch platform shall consist of cantilever type structure to hold and support the craft. The winch shall be electric motor driven .The life boat with full person loaded shall be so designed to control the descent without the aid of electric power.</p> <p>Diesel fuel tank shall have storing capacity of minimum 24 hours of operation.</p> <p>The craft shall be sea worthy for 100 years storm conditions. Complete radio system shall be provided. All electrical devices shall meet the requirement for the area classification in which they are installed and the controls shall operate in a fail safe mode, for the electrically driven winch of launch and recovery unit.</p> <p>The life boat shall conform to SOLAS.</p> <p>3.7.7.4 Life rafts and life ring buoys</p> <p>Life Raft shall be located suitably at the most frequented areas (minimum two at each main and cellar deck) and scramble net to be mounted adjacent to each life raft. The stowage line length of life raft shall be such that it is suitable for each specific location where it is to be mounted on deck(s).Life rafts shall be installed in self-launching mode. Life raft cradle shall be inclined at an angle 30 degree downward. The life ring buoys with buoyant line and a self-igniting light capable of withstanding an immersion test up to 0.5 meters and capable of burning for not less than 45 minutes with a luminous intensity of not less than 2 candle power shall be kept all around on all the faces of the platform. Minimum quantity of these items is</p>				
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	<p>indicated in Description of work and shall be decided during detailed engineering. It shall confirm to SOLAS and have approval of statutory authority.</p> <p>3.7.8 PERSONNEL PROTECTION SYSTEM</p> <p>Following safety and personnel protection features shall be provided on the platform:</p> <p>a) Venting facility for depressurizing up to atmospheric pressure for all equipment.</p> <p>b) Facility for purging with inert gas during start-up/ shut down for all equipment.</p> <p>c) Facility to fill small quantity of potable water in vessels and low points of piping wherever Ferric Sulfide is expected to form and settle.</p> <p>d) Portable breathing air packs (Minimum Quantity as specified in Description of work) with face piece assembly, breathing valve, regulator, high pressure hose, compressed of adequate capacity (to be firmed up in detail engineering) air with an audible pressure warning device and harness assembly to protect from H2S.</p> <p>e) Lead acetate paper in sufficient quantities (minimum 500 nos. on process platform).</p> <p>f) Eye goggles (Minimum Quantity as specified in Description of work) cup type or rubber framed, equipped with approved impact resistance glass.</p> <p>g) H2S and safety information charts at strategic locations.</p> <p>h) Portable eye wash facilities and Safety shower and eye wash station (Refer Functional Specification 5102) shall be provided.</p> <p>i) Emergency and Escape lighting shall be provided on all escape routes and embarking/ mustering area, also at strategic locations such as passage ways and stair ways, in public areas, critical control centers.</p>			
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All emergency and escape luminaries shall be certified for use in Class I, Division I hazardous area.(refer Electrical Design Criteria and Functional Safety Specification)

j) The provision of escape through boat landing shall have provision for jumping ropes.

k) The boat landing shall be three stages landing for effective use in high and low tide condition.

3.7.9 HOT SURFACE PROTECTION

Personnel protection against accidental contact with hot surface shall be provided. The minimum requirement to be met is API RP 14C.

3.7.10 PREPARATION FOR SHIPMENT

Prior to shipment, all instrumentation and other equipment vulnerable to damage shall be disassembled and boxed separately for shipment. All items shall be adequately packed and protected against damage during shipment.

Each crate, bag or packages shall be clearly identified with the purchase order number and identification symbol, and shall be securely fastened to the skid.


Exposed machined surfaces shall be coated with an easily removable heavy duty rust preventative.

All flanged openings shall be protected with steel plate covers attached by proper bolting and sealed with plastic compound.

All electrical control enclosures shall be appropriate plugged at entries and loaded with silica gel bags.

Screwed connections shall be protected with threaded forged steel plugs. Contractor shall state in the proposal his recommendations for long term storage (up to 12 months) for both indoor and open air storage in a marine environment.

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<p>Each item of equipment shall be checked for its suitability to resist horizontal forces during sea transportation. Where equipment is not adequate, brackets for attaching sea fastenings shall be provided by the Contractor.</p>				
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