PETROBRAS	TECHNICAL SPECIFICATION	N°:	I-ET-3010.2Q-5268-968-P4X-001
	CLIENT: MARLIM LESTE E SUL		SHEET: 1 of 35
	JOB: BASIC DESIGN – REVIT I		
	AREA: MARLIM LESTE E SUL		
	TITLE: **RISER PULL-IN AND PULL-OUT SYSTEM**		ESUP
			INTERNAL

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INDEX OF REVISION

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	REVISION OF TEXT FORMATTING AND ITEMS AS INDICATED.
B	REVISION OF COVERSHEET TEMPLATE AND ITEM 4.5.1 AS INDICATED.

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E
DATE	JUN/14/24	JUN/18/24	JUL/16/24			
EXECUTION	UQX8	UQX8	UQX8			
CHECK	CLYZ	CLYZ	HR7O			
APPROVAL	ECKA	ECKA	CXM6			

SUMMARY

1 OBJECTIVE

1.1 This technical specification covers the minimum technical requirements for the design, materials, fabrication, assembly, inspection, testing, certification, preparation for shipment, installation, onboard integration, pre-commissioning, commissioning and final acceptance tests of all Riser Pull-In and Pull-Out System.

1.2 These requirements shall be complied with, in conjunction with other applicable MANUFACTURER's documents and standards.

2 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

2.1.1 All terms and definitions are established in the latest revision of I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS. For instance:

- INTEGRATOR is the Company that will execute all the interconnections amongst Modules.
- MANUFACTURER is defined as the responsible by fabrication of equipment or components internal to the Package.
- OWNER is defined as PETROBRAS.
- PACKAGER is defined as the responsible for project, assembly, construction, fabrication, test and furnishing of the Package.
- SUPPLIER is defined as the responsible for the detailed design, purchase all instrument, equipment, system, unit, material, assembly and construction, commissioning, the lift, hook up, installation and integration of all Modules on the Unit Hull.
- UNIT is defined as the FPSO (Floating Production Storage and Offloading), FSO (Floating Storage and Offloading), SS (Semi-Submersible) or Fixed Offshore Unit.
- Document supplied by OWNER: Project's document to be furnished by OWNER to PACKAGER/MANUFACTURER, this document contain information to be used during equipment design and fabrication. It is indicated by the expression: [document supplied by OWNER].

2.2 Abbreviations

- ABL Above Base Line
- FPSO Floating, Production, Storage and Offloading Production Unit
- HPU Hydraulic Power Unit
- MBL Minimum Breaking Load
- SWL Safe Working Load

3 SCOPE OF SUPPLY

3.1 Riser Pull-In and Pull-Out System shall be delivered with all equipment and components listed below:

- Main Winch for pull-in and pull-out operation (1);
- Auxiliary Service Winch for assistance of pull-in and pull-out operation (1);
- Wire rope;
- Spooling device;
- Operator Cabin;
- Sheave Trolley with:
  Trolley platform for sheaves maintenance access;
  Horizontal deviation sheave;
  Vertical pivoting sheave for pull-in and pull-out operation;
  Auxiliary sheave for assistance of pull-in and pull-out operation;
  Handling Service Winch for assistance of pull-in and pull-out pre-operation activities (1);
  Handling sheaves (at least 1, depending on MANUFACTURER solution);
  Hydraulic skidding;
  Drag chains.

- Overhead Crane for cargo handling and equipment positioning;
- Hydraulic Power Unit.

3.2 PACKAGER/MANUFACTURER scope of supply shall include the following:

- A complete engineering package including design, fabrication, inspection, factory and site testing, commissioning, certification, documentation and data required on this technical specification and by Classification Society.
- A full 3D model of the equipment in format ISO 14306:2017 (*.jt), ACIS (*.sat) or Microstation V8 (*.dgn) or in format STEP (ISO10303 Standard for Exchange of Product model data or equivalent).
- Electrical and instrumentation installation, including cables, junction boxes, grounding and all necessary instruments, ancillaries and supports.
- Nameplates manufactured in SS 316 in Portuguese & English for all equipment and instruments.
- Spare parts recommended for installation, commissioning and start-up.
- All consumables and special tools for installation, commissioning, start-up and maintenance.
- Technical assistance during assembly, installation, pre-commissioning, commissioning and start-up phases.
- Engineering, maintenance and operators training program.
- Warranty.
- Preparation for shipment and preservation, including equipment handling conditioning and storage at job site.

4 RULES, CODES, STANDARDS AND REFERENCE DOCUMENTS

4.1 Normative References

4.1.1 PACKAGER/MANUFACTURER shall comply with the requirements of this technical specification, documents as stated below and with those referred to herein.

4.1.2 As a general guideline, in case of conflicting requirements between this technical specification and other cited references, the most stringent shall prevail. If necessary the PACKAGER/MANUFACTURER may revert to OWNER for clarification.

4.2 Brazilian Governmental Regulation Rules

4.2.1 Brazilian Government Regulations Rules are mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein.

- NR 10 Segurança em Instalações e Serviços em Eletricidade
  (Safety in Electrical Facilities and Services)
- NR 12 Segurança no trabalho em máquinas e equipamentos
  (Safety in services in machines and equipment)
- NR 13 Caldeiras e Vasos de Pressão
  (Boilers and Pressure Vessels)
- NR 17 Ergonomia
  (Ergonomics)
- NR 26 Sinalização de Segurança
  (Safety and Health at Oil Plataforms)
- NR 37 Segurança e Saúde em Plataformas de Petróleo
  (Safety and Health at Oil Plataforms)

- NR10, NR-12, NR-13, NR-17, NR-26 and NR-37 establish electrical panels on-off standard, nameplate information, safety signaling and emergency warnings. They also establish construction design criteria for ladder, guardrail for walkways, footer and access fitting. Furthermore, there are specific documentation and test requirements for pressure vessels.

- INMETRO Resolution 115.
- ANATEL Resolutions about telecommunication equipment homologation and licenses requirement.

4.3 Classification Society Rules

4.3.1 PACKAGER/MANUFACTURER shall perform the work in accordance with the requirements of Classification Society Rules.

4.3.2 Where Classification Society Rules requirements exceed OWNER requirements, the Classification Society Rules shall take precedence.

4.3.3 PACKAGER/MANUFACTURER is responsible for submitting to the Classification Society all documentation in compliance with stated rules.

4.4 Applicable Codes and Standards

4.4.1 The latest editions of the following codes and standards shall be fully complied with:

- Classification Society Rules for Riser Pull-In and Pull-Out System
- Classification Society Lifting Appliances for Overhead Cranes
- API 9A - Specification for Wire Rope or
- BS EN-12385 - Steel Wire Ropes
- NOTE: In case of Classification Society does not have rule for Riser Pull-In and Pull-Out System, OWNER suggests DNVGL-OS-E301 - position mooring as the applicable rule.

4.5 Applicable and Reference Documents

4.5.1 The following documents shall be used as reference or followed wherever they are mentioned throughout this specification:

General

- DR-ENGP-M-I-1.3 - SAFETY ENGINEERING GUIDELINE
- DR-ENGP-I-1.15 - COLOR CODING
- I-ET-3000.00-0000-940-P4X-002 - SYMBOLS FOR PRODUCTION UNITS DESIGN
- I-ET-3000.00-1200-940-P4X-001 - TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN
- I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS
- I-ET-3010.00-1350-940-P4X-001 - SYSTEMS OPERATION PHILOSOPHY
- I-ET-3000.00-1000-941-PPC-001 - METOCEAN DATA
- I-LI-3010.2Q-1200-940-P4X-002 - EQUIPMENT LIST

Safety

- I-DE-3010.2Q-1200-94A-P4X-001 - AREA CLASSIFICATION - GENERAL
- I-FD-3010.2Q-5400-947-P4X-001 - SAFETY DATA SHEET

Process

- I-RL-3010.2Q-1200-940-P4X-001 - GENERAL SPECIFICATION FOR AVAILABLE UTILITIES

Arrangement & Structure

- I-DE-3010.2Q-1200-942-P4X-001 - GENERAL ARRANGEMENT
- I-DE-3010.2Q-1419-942-P4X-001 - M-09 PIG LAUNCHERS/RECEIVERS AND PRODUCTION & INJECTION MANIFOLDS EQUIPMENT LAYOUT PLAN
- I-DE-3010.2Q-1352-140-P4X-006 - UPPER RISER BALCONY
- I-DE-3010.2Q-1352-140-P4X-007 - LOWER RISER BALCONY
- ~~I-DE-3010.2Q-1352-140-P4X-018 - DIVING STATIONS~~
- I-DE-3010.00-1400-140-P4X-003 - STANDARD-STEEL GUARDRAIL - TYPICAL DETAILS
- I-DE-3010.00-1400-140-P4X-004 - GENERAL NOTES FOR TOPSIDES STRUCTURES
- I-DE-3010.00-1400-140-P4X-011 - STANDARD-PULTRUDED GUARDRAIL - TYPICAL DETAILS

Submarine

- I-ET-3010.2Q-1350-940-P56-001 - FPSO STRUCTURES AND FACILITIES FOR RISER SYSTEM (HOLD)
- I-DE-3A26.00-1500-941-P56-002 - RISERS SUPPORT ARRANGEMENT (HOLD)

Naval

- I-ET-3010.2Q-1350-960-P4X-003 - DESIGN PREMISSES - NAVAL ARCHITECTURE
- I-DE-3010.2Q-5139-944-P4X-002 - PIPING AND INSTRUMENT DIAGRAM HYDRAULIC SYSTEM FOR RISER PULL-IN SYSTEM

- I-RL-3010.2Q-1350-960-P4X-002 - MOTION ANALYSIS

Mechanical & Piping

- I-ET-3010.00-1200-251-P4X-001 - Bolt Material
- I-ET-3010.00-1200-431-P4X-001 - Thermal Insulation for Maritime Installations
- I-ET-3010.00-1200-955-P4X-001 - Welding
- I-ET-3010.00-1200-955-P4X-002 - Requirements for Welding Inspection
- I-ET-3010.00-1200-300-P4X-001 - Noise and Vibration Control Requirements
- I-ET-3010.00-1200-956-P4X-002 - General Painting
- I-ET-3010.00-1200-200-P4X-001 - Minimum Requirements for Piping Mechanical Design and Layout
- I-ET-3010.2Q-1200-200-P4X-002 – Piping Specification for Hull

Electrical

- I-ET-3010.00-5140-700-P4X-001 - Specification for Electrical Design for Offshore Units
- I-ET-3010.00-5140-700-P4X-002 - Specification for Electrical Material for Offshore Units
- I-ET-3010.00-5140-700-P4X-003 - Electrical Requirements for Packages for Offshore Units
- I-ET-3010.00-5140-700-P4X-005 - Requirements for Human Engineering Design for Electrical System of Offshore Units
- I-ET-3010.00-5140-700-P4X-007 - Specification for Generic Electrical Equipment for Offshore Units
- I-ET-3010.00-5140-700-P4X-009 - General Requirements for Electrical Material and Equipment for Offshore Units
- I-ET-3010.00-5140-712-P4X-001 - Low-Voltage Induction Motors for Offshore Units
- I-ET-3010.00-5140-741-P4X-004 - Specification for Low-Voltage Generic Electrical Panel for Offshore Units
- I-ET-3010.00-5140-797-P4X-001 - Electrical System Automation Architecture
- I-DE-3010.00-5140-700-P4X-003 - Grounding Installation Typical Details
- I-DE-3010.00-5140-797-P4X-001 - Electrical System Automation Architecture Diagram

Automation

- I-ET-3010.00-1200-800-P4X-002 - Automation, Control and Instrumentation on Package Units
- I-ET-3010.00-5520-888-P4X-001 - Automation Panels
- I-ET-3010.2Q-1200-800-P4X-001 - Instrumentation Additional Technical Requirements
- I-ET-3010.2Q-1200-800-P4X-005 - Field Instrumentation
- I-ET-3010.2Q-1200-800-P4X-014 - Automation Interface of Package Units

Telecommunications

- I-MD-3010.00-5510-760-PPT-001 - General Criteria for Telecommunications Design
- I-ET-3010.00-5514-76A-PPT-001 - Hull CCTV System
- I-ET-3010.00-5264-769-PPT-002 - Hull Shutdown Telecommunication System
- I-ET-3010.00-5512-762-PPT-002 - LTE Transmission System
- I-DE-3010.00-5515-762-PPT-001 - GMDSS and Radio Operational One Line Diagram
- I-DE-3010.2Q-5514-76A-PPT-003 - Topsides CCTV System One Line Diagram
- I-DE-3010.2Q-5517-768-PPT-005 - Topsides Structured Cabling One Line Diagram
- I-DE-3010.2Q-5517-768-PPT-006 - Topsides WLAN System One Line Diagram
- I-DE-3010.2Q-5510-760-PPT-007 - Topsides M-09 Module Telecommunications System Arrangement
- I-DE-3010.2Q-5514-76A-PPT-001 - Hull CCTV System One Line Diagram
- I-DE-3010.2Q-5517-768-PPT-001 - Hull Structured Cabling One Line Diagram
- I-DE-3010.2Q-5517-768-PPT-004 - Hull WLAN System Arrangement
- I-DE-3010.2Q-5518-767-PPT-001 - Hull Public Address One Line Diagram
- I-DE-3010.2Q-5264-769-PPT-001- Hull Telecommunications Energy System One Line Diagram

- SUPPLIER shall consult 3D model in case documents with HOLD status were not supplied during bidding phase.
- SUPPLIER shall issue updated Riser Pull-In and Pull-Out System technical specification and material requisition for purshase purpose.

4.6 Packager/Manufacturer Responsibility

4.6.1 Any conflict between the requirements of this specification and related codes and standards shall be presented in writing for OWNER's resolution prior to manufacturing.

4.6.2 PACKAGER/MANUFACTURER shall assume sole contractual and total engineering responsibility for the items supplied.

4.6.3 PACKAGER/MANUFACTURER's responsibility shall also include but not be limited to:

- Technical responsibility for the entire scope of supply.
- Resolving all engineering questions and/or problems relating to design and manufacturing.
- Providing details as requested, for the main and auxiliary equipment, relating to design and manufacturing.
- Submitting to the certifying/classification authority the documentation as described in the latest edition of their rules for equipment on offshore facilities.
- If necessary, attending HAZOP meetings arranged by OWNER.
- Pre-Commissioning, Commissioning and Training.
- NOTE: Installation at site by others (however, presence of supervision will be required).

4.6.4 Compliance by the PACKAGER/MANUFACTURER with the provisions of this specification does not relieve the PACKAGER/MANUFACTURER of his responsibility to furnish equipment and accessories of a proper mechanical design suited to meet the specified service conditions.

4.6.5 PACKAGER is responsible for all coordination with MANUFACTURERS and collections of all details, drawings and data to achieve optimum design and full submission of all documents requested in the specification.

5 GENERAL REQUIREMENTS

5.1 Riser Pull-In and Pull-Out Operation

5.1.1 The direct riser pull-in and riser pull-in via keelhauling are presented in simplified form at Figures 1 and 2. For a complete operation description, PACKAGER/MANUFACTURER shall consult I-ET-3010.2Q-1350-940-P56-001 - FPSO STRUCTURES AND FACILITIES FOR RISER SYSTEM.

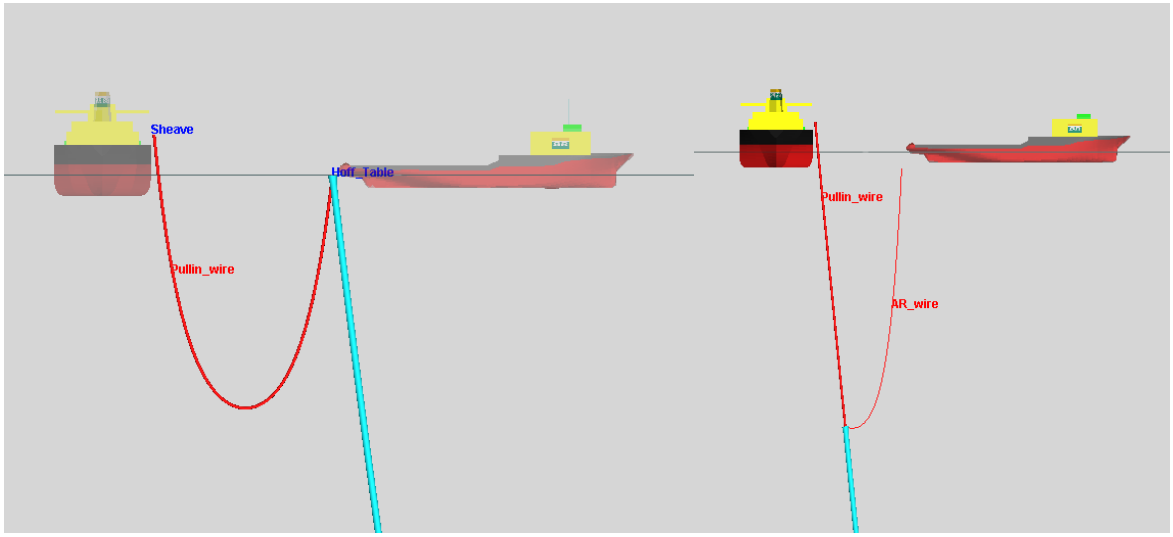

Figure 1: Direct riser pull-in with portside approaching.

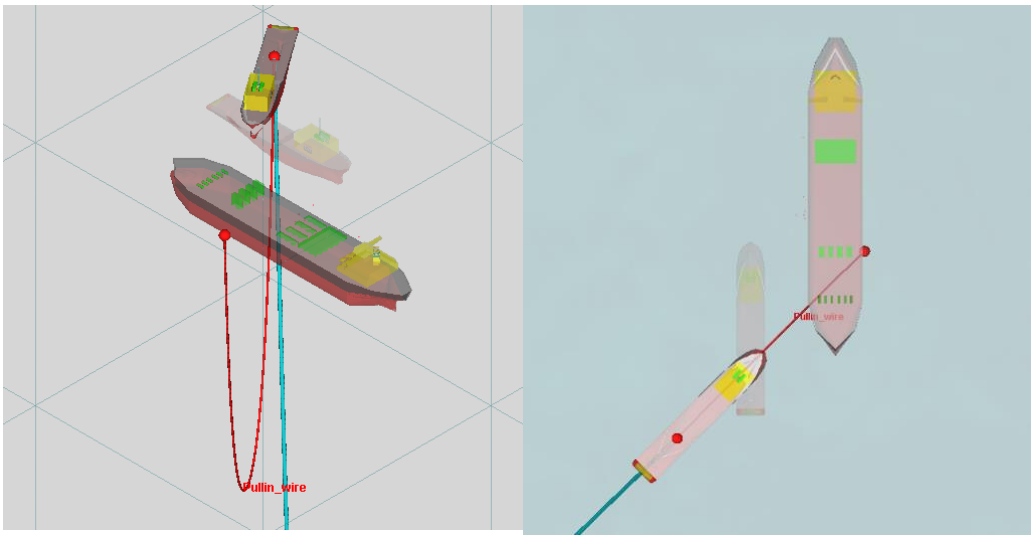

Figure 2: Riser pull-in via keelhauling with starboard approaching.

5.2 Riser Balcony Configuration

5.2.1 UNIT Riser Balcony is located on the portside of the vessel and there are three levels: Riser Pull-in Structure (RPS), Upper Riser Balcony (URB) and Lower Riser Balcony (LRB) connected to submarine systems by 83 slots. It is presented in simplified form at Figure 3a.

5.2.2 These slots will connect flexible risers of oil production, water injection, gas injection, service, export gas, export oil and control umbilical risers. It is not foreseen rigid rises.

5.2.3 Flexible and umbilical risers will be connected to the hull through lower and Upper I-Tubes attached to balcony sections, as shown in Figure 3b. The Upper I-Tube will anchor the riser axial loads on Upper Riser Balcony (URB), and the Lower I-Tube arranged into two rows of Lower Riser Balcony (LRB) will incorporate a diverless bellmouth (BSDL-SI) to support the riser bend stiffener.

5.2.4 Lower Riser Balcony has two rows of I-Tubes, where internal I-Tubes are dedicated to the risers from starboard and external I-Tubes are dedicated to the rises from portside.

5.2.5 Diverless bellmouth (BSDL-SI) is sloped to accommodate individual riser angles, while the anchoring of the risers will be at Upper Riser Balcony (URB), through a hang-off collar mounted on the top flange of the upper guide tube.

5.2.6 For a complete description, PACKAGER/MANUFACTURER shall consult I-ET-3010.2Q-1350-940-P56-001 - FPSO STRUCTURES AND FACILITIES FOR RISER SYSTEM (HOLD). Riser balcony configuration and hull structural modifications may occur at detailed design and all updates shall be provided by SUPPLIER and informed to PACKAGER/MANUFACTURER.

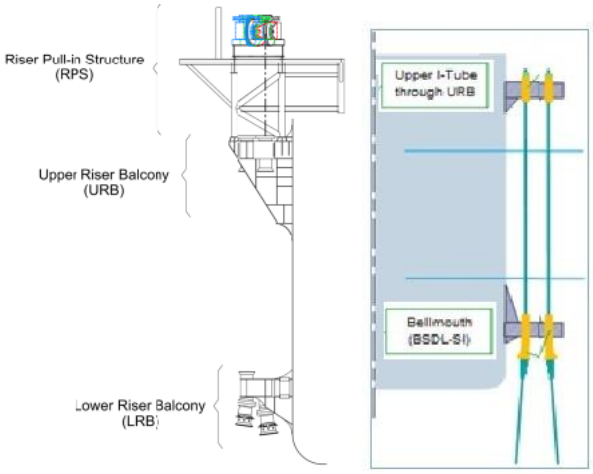

Figure 3: Riser Balcony Configuration.
NOTE: Flexible and umbilical risers represented in blue.

5.2.7 Riser Pull-in Structure (RPS) has primary and secondary beams, hatches and rails as illustrated at Figure 4. The Riser Pull-in Structure (RPS) width is 8.775m and the distance between rails is 4.960m. The hatch minimum opening size is 1.400m and the distance between I-Tubes center is 3.500m or 3.650m. All dimensions at drawings and 3D model shall be confirmed during detailed design by SUPPLIER and informed to PACKAGER/MANUFACTURER.

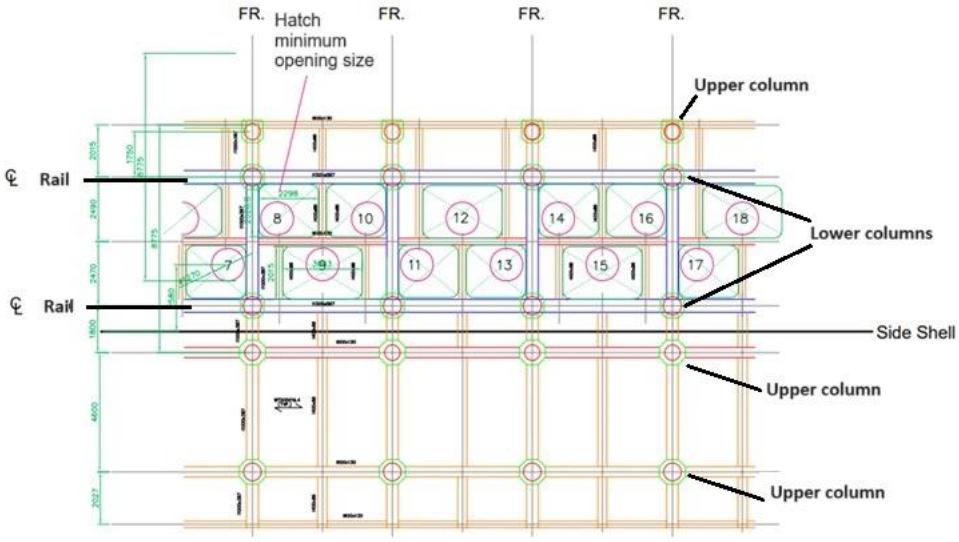

Figure 4: Riser Pull-in Structure (RPS)

5.3 Riser Pull-In and Pull-Out System

5.3.1 Riser Pull-In and Pull-Out System shall be designed for the following applications:

- Installation and uninstall of flexible and umbilical risers.
- Installation and uninstall of main and service wire ropes, including their connection to Sheave Trolley, assembling and disassembling of sockets and hooks, if necessary.
- Handling and positioning of marine materials, riser and piping accessories, as transfer rigging, A&R wire rope, pull-heads, hang-off colars, closing spools, SDV interface spools, mockups and dummy spools, including assembling and disassembling of these materials at Upper Riser Balcony.
- Handling and positioning of diving station equipment, bellmouths and their components.

5.3.2 Riser Pull-In and Pull-Out System shall dispose of one main and one auxiliary service fixed winches, using together only one Sheave Trolley skid system, which travels along the Riser Pull-in Structure (RPS) to reach different Upper I-Tubes by dedicated track or rails. Schematic Pull-In and Pull-Out System is presented at Figure 5.

5.3.3 The pull-in wire ropes shall be routed through wire rope centralizers, sheaves, supports and guides as required. The pull-in wire ropes shall be able to access every riser position and shall not interfere with installed risers. The FPSO structures, piping and installation facilities shall not damage the wire rope or clash with the riser during pull-in and pull-out operation.

5.3.4 SUPPLIER shall do an interference assessment to check all clashing issues on routing pull-in wire ropes to the sea. It shall consider possible interferences between Riser Pull-In and Pull-Out System components and M09 columns, diving stations, hull structures, piping accessories, top interface

spools, handling devices, riser balconies and submarine equipment (risers in the vicinities and sea water lift pumps hoses at keelhauling operation).

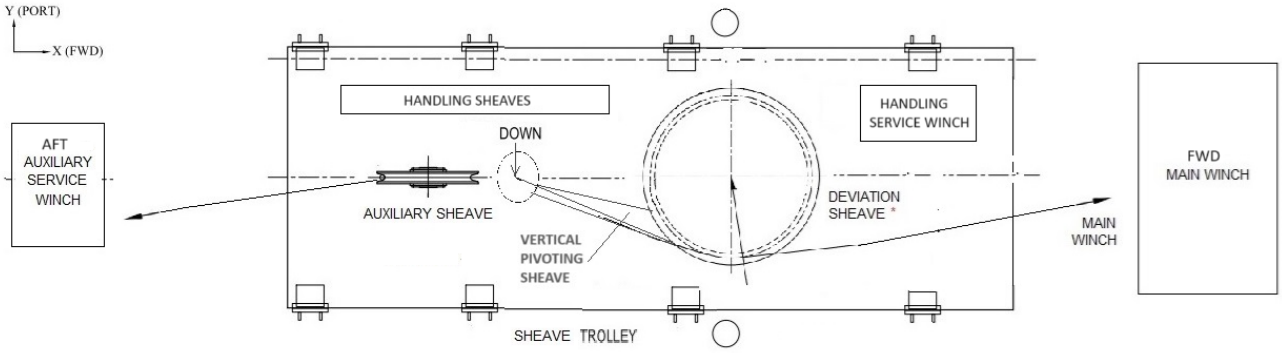

Figure 5: Schematic Pull-In and Pull-Out System.

5.3.5 Sheave Trolley skid shall have the following arrangement of sheaves:

- Horizontal deviation sheave to guide main wire rope with minimum fleet angle until vertical pivoting sheave.
- Vertical pivoting sheave to guide main wire rope to the sea, centered with the Upper I-Tube, in all Sheave Trolley locking positions.
- Auxiliary sheave to guide service wire rope to the sea, centered with the Upper I-Tubes, in all Sheave Trolley locking positions.
- Main and service wire ropes shall have simultaneous downward access to Upper I-Tube, in all Sheave Trolley locking positions. Both wire rope shall achieve the Lower Riser Balcony without interference with structures piping and installation facilities, for example.
- Handling service winch and handling sheaves shall be alignment to assist pull-in pre-operation activities, preparing main and service wire ropes. The number of handling sheaves may differ according to MANUFACTURER solution.

5.3.6 Regarding Sheave Trolley, the design shall assure wire rope routing and secure the functionality of pull-in operation. Once there are two rows of I-Tubes, pull-in pre-operation activities could increase because of constant wire rope alignment. For this reason, MANUFACTURER solution for vertical pivoting sheave shall comply with at least one of displacement alternatives listed below at Figure 6.

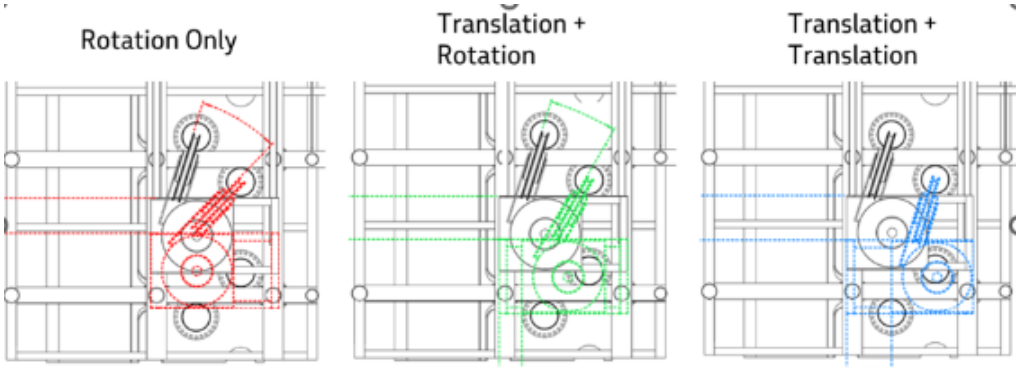

Figure 6: Vertical pivoting sheave displacement alternatives.

5.3.7 Regardless Sheave Trolley locking position, vertical pivoting sheave shall guarantee that main wire rope be aligned with the center of I-Tube. It can be achieved with vertical pivoting sheave displacement, in different directions:

- Rotation only, in order to perform the pull operation between two neighbor's I-Tubes in sequence but relocating sheave trolley position when necessary.
- Rotation and translation in only one direction, in order to perform the pull operation between two neighbor's I-Tubes in sequence, using a sliding base mounted under pivoting vertical sheave, without change Sheave Trolley locking position.
- Translation in two orthogonal directions, in order to perform the pull operation between two neighbor's I-Tubes in sequence, using a sliding base mounted under pivoting vertical sheave, without change Sheave Trolley locking position.

5.3.8 It is also acceptable a vertical pivoting sheave with telescopic arm, provided that it is secured the functionality of pull-in operation.

5.3.9 SUPPLIER shall evaluate with MANUFACTURER the best alternative, considering pull-in operation requirements, dimensional limitations and geometrical constrains of Riser Pull-in Structure (RPS) configuration.

5.3.10 Considering the hatches size, the Sheave Trolley locking mechanism shall be installed external to rails. It is also required a locking device for vertical pivoting sheave and its sliding base.

5.3.11 Riser Pull-In and Pull-Out System shall also dispose of one Overhead Crane with retractable extension or a telescopic arm to surpass vessel side and reach the sea level, passing through Upper I-Tubes or through openings on the diving station floor, as indicated at Figure 7.

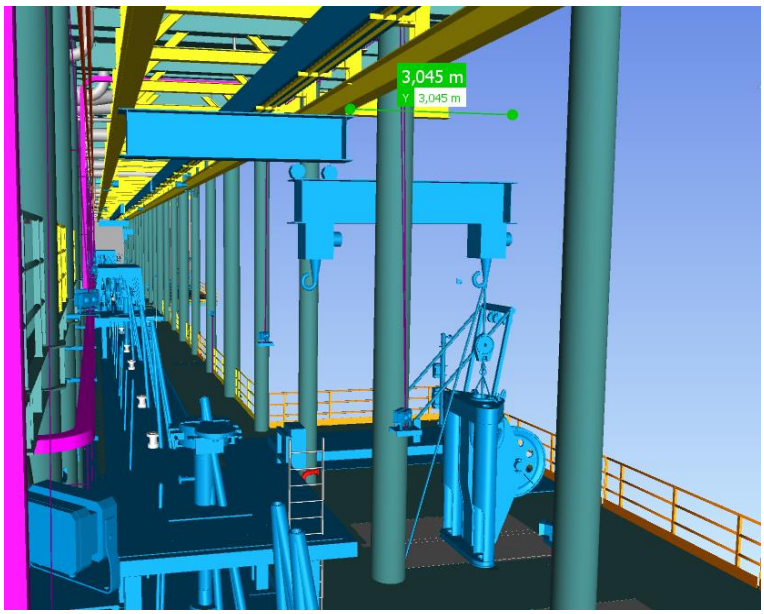

Figure 7: Overhead Crane sketch and opening on the diving station floor.

5.3.12 For the diving stations and others structures located over the Upper Riser Balcony (URB), SUPPLIER shall check possible clashes and treat them.

5.3.13 HULL SUPPLIER shall provide an opening on the diving station floor covered with a flush removable hatch, in order to allow the handling of piping accessories and top interface spools.

5.3.14 The procedure to hang-off and then move closing spools and SDV interface spools from Upper Riser Balcony (URB) to Riser Pull-in Structure (RPS) shall be done with Overhead Crane and auxiliaries from topside. These auxiliaries are not MANUFACTURER scope of supply. It shall be provided by SUPPLIER.

5.3.15 Transfer rigging, pull-head retrieval, bellmounths and their components maintenance shall be considered to define number and dimensions of hatches along diving station floor.

5.4 General Arrangement

5.4.1 UNIT General Arrangement is presented at I-DE-3010.2Q-1200-942-P4X-001 - GENERAL ARRANGEMENT. An overview of Riser Pull-In and Pull-Out System is presented at I-DE-3010.2Q-1419-942-P4X-001 - M-09 PIG LAUNCHERS/RECEIVERS AND PRODUCTION & INJECTION MANIFOLDS EQUIPMENT LAYOUT PLAN. Arrangement and modules structural modifications may occur at detailed design and all updates shall be provided by SUPPLIER and informed to PACKAGER/MANUFACTURER.

5.4.2 Riser Pull-In and Pull-Out System is located on the portside of the vessel and it shall be installed at 1st level. FWD Main Winch, Sheave Trolley, Operator Cabin and HPU are illustrated at Figure 8, for reference only. Sheave Trolley parking area shall not be above any Upper I-Tube and shall be kept at FWD in order to optimize pull-in pre-operation activities. In the FWD position, there is no need to disconnect main wire from Sheave Trolley in order to perform cargo handling and displacement of large equipment, as diving equipment, through Riser Pull-in Structure (RPS).

5.4.3 HULL SUPPLIER shall foresee safe escape route on Riser Pull-in Structure (RPS). Escape route starting from Operator Cabin shall not cross wire rope neither face winches drive system. Depending on MANUFACTURER solution, equipment size and their arrangement, FWD deck extension may be necessary to include this escape route and keep Riser Pull-In and Pull-Out System equipment in safe area zone.

5.4.4 Sheave Trolley is indicated at Figure 9 under M09 and AFT Auxiliary Service Winch is not shown at 3D model. Overhead Crane, including its retractable arm and hook, shall pass over Sheave Trolley and have an ultralow headroom hoist configuration. Portside monorail beam, signaled at Figure 10, shall be replaced to allow Overhead Crane retractable arm surpasses vessel side and reach the sea level.

5.4.5 PACKAGER/MANUFACTURER shall define the final arrangement of Riser Pull-In and Pull-Out System, considering dimensional limitations and geometrical constrains of Riser Pull-in Structure (RPS), as the distance between rails, distance between M09 columns, distance between monorails, maximum height and hatches size.

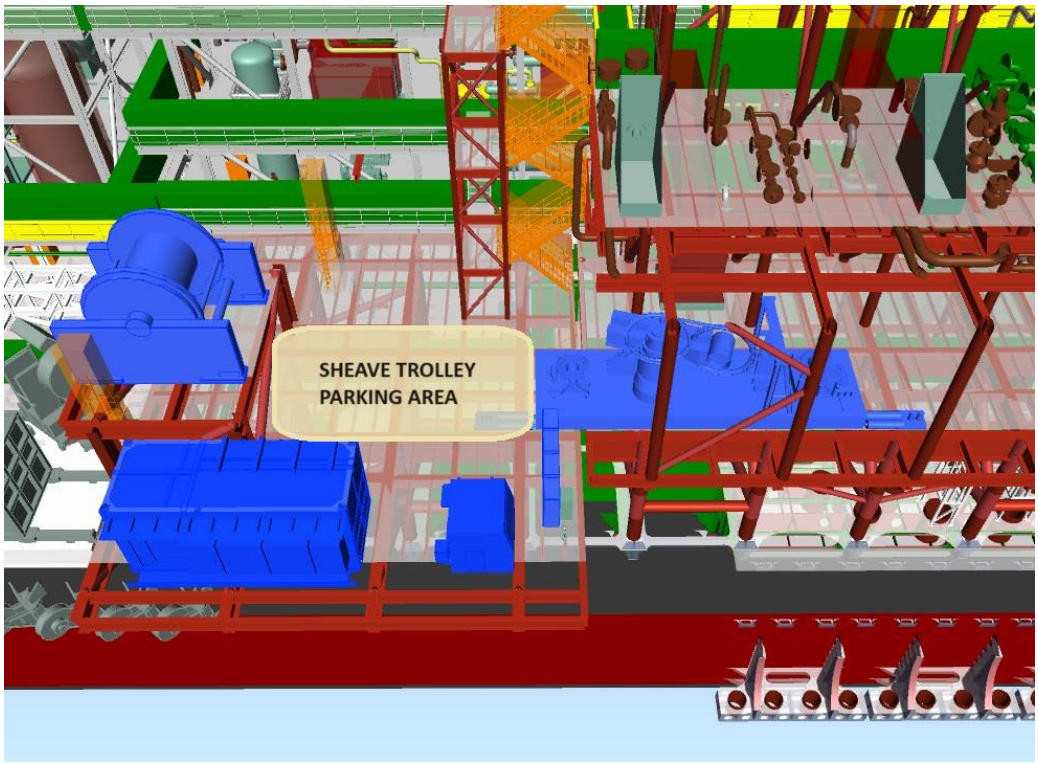

Figure 8: FWD Main Winch, Sheave Trolley, Operator Cabin and HPU.

Figure 9: Sheave Trolley under M09.

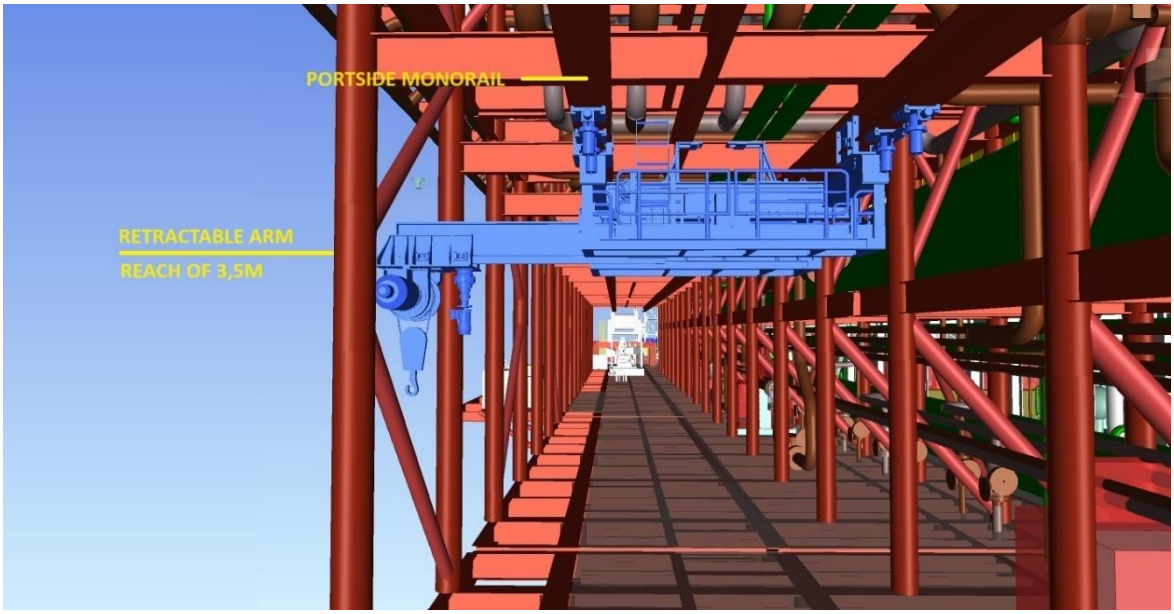

Figure 10: Overhead Crane and its portside monorail beam.
NOTE: Electrical cables tray and tubing supports are omitted.

5.4.6 All dimensions at 3D model shall be confirmed during detailed design by SUPPLIER and informed to PACKAGER/MANUFACTURER.

5.4.7 HULL SUPPLIER shall foresee at least one anchor point or more to allow execution of Site Acceptance Tests (SAT). Main and service wire ropes shall be fixed on anchor points installed at Upper Riser Balcony (URB) or Lower Riser Balcony (LRB).

6 DESIGN REQUIREMENTS

PACKAGER/MANUFACTURER shall comply with general design requirements defined in this section.

6.1 Operation Environment

6.1.1 The equipment supplied shall be suitable for the marine environment and range of ambient condition including, atmospheric pressure, relative humidity, rainfall, air temperature (dry bulb), characteristic monthly values and wind motions defined in the document I-ET-3000.00-1000-941-PPC-001 - METOCEAN DATA.

6.1.2 Riser Pull-In and Pull-Out System shall be designed considering that the Site Acceptance Tests (SAT), which includes load tests, will be performed at integration site where temperature can be lower than the absolute minimum temperature established at metocean data.

6.1.3 If temperature during the tests may be expected to be lower than the temperature mentioned in the project documentation, the lower value shall be considered as the reference of minimum ambient temperature, for steel selection and qualification of welders and welding procedures.

6.2 Motion Requirements

6.2.1 Riser Pull-In and Pull-Out System shall be designed for induced hull motion factors. The necessary design data and information on motion requirements are given by I-ET-3010.2Q-1350-960-P4X-003 - DESIGN PREMISSES - NAVAL ARCHITECTURE and I-RL-3010.2Q-1350-960-P4X-002 - MOTION ANALYSIS.

6.2.2 All equipment shall be able to withstand when the UNIT is subjected to 100-year return period environmental conditions and to operate when the UNIT is subjected to 1-year return period environmental conditions, at any draft from fully loaded to 20% loaded/ballasted condition, and under inclination (static and dynamic) as per Classification Society Rules.

6.2.3 SUPPLIER shall inform PACKAGER/MANUFACTURER any data from the model tests, which contradicts the specified data. Any action on the revised data will be subject to agreement with the SUPPLIER.

6.3 Design Life

6.3.1 Riser Pull-In and Pull-Out System shall be designed and constructed for a design life of 25 years without the need for change of any major component due to wear, fatigue, corrosion or material failure.

6.3.2 During the FPSO installation phase, the system will be fully utilized. After the installation phase, the system will be utilized for installation of new risers, riser replacement and riser uninstall. It also be utilized for assist the replacement of bellmouths and for equipment handling.

6.3.3 PACKAGER/MANUFACTURER shall include a schedule stating the expected time between major overhauls of the equipment considering their reduced usage after the installation phase.

6.4 Safety Requirements

6.4.1 All equipment, devices, electrical components and instrumentation of the Riser Pull-In and Pull-Out System shall be designed and constructed to be used in an area classified in accordance with international codes, statutory regulations, Classification Society Rules and DR-ENGP-M-I-1.3 -

SAFETY ENGINEERING GUIDELINE and I-DE-3010.2Q-1200-94A-P4X-001 - AREA CLASSIFICATION - GENERAL.

6.4.2 All equipment and components shall be at least IP56 and certified for installation and operation in a hazardous area Zone 2, Gas Group II A and Temperature Class T3, unless they are located on safe area zone. Riser Pull-In and Pull-Out System location shall be confirmed during detailed design by SUPPLIER and informed to PACKAGER/MANUFACTURER.

6.4.3 According to NR-37, effective since February 1st, 2022, item 37.24.8, mechanical equipment installed in hazardous areas shall be evaluated according to the requirements in technical standard ABNT NBR ISO 80079-36 or ABNT NBR ISO 80079-37.

6.4.4 Thermal insulation for personnel protection according to I-ET-3010.00-1200-431-P4X-001 and Safety signaling in Portuguese & English language.

6.4.5 Guards and/or insulation shall be provided on hot surfaces to protect personnel who may come into contact with these surfaces, during operating or maintenance activities.

6.4.6 In hazardous areas, heated surfaces > 725°F (385°C) shall be insulated, cooled or protected by other means.

6.5 Materials

6.5.1 The required materials for structural design, construction, machinery and components of the Riser Pull-In and Pull-Out System shall be in accordance with this technical specification. When not specified, PACKAGER/MANUFACTURER is responsible for materials selection.

6.6 Painting and Color

6.6.1 PACKAGER/MANUFACTURER paint system shall be according to I-ET-3010.00-1200-956-P4X-002 – General Painting.

6.6.2 Color code adopted shall be in accordance with DR-ENGP-I-1.15 - COLOR CODING.

6.6.3 All structure, equipment and devices shall be protected against internal and external corrosion considering that the system parts will be exposed to sea spray and its operation in exposed marine environment with a corrosive atmosphere.

6.7 Noise Control

6.7.1 Noise control analysis is a mandatory item to be carried out. Specification I-ET-3010.00-1200-300-P4X-001 - Noise and Vibration Control Requirements shall be followed. These documents establish the minimum requirements for noise control to be observed and describes the basic procedures for the measurement and reporting of airborne sound levels of equipment.

6.7.2 The technical information given in EN ISO 11688-1:2009 shall be used as means to design of low-noise machinery. EN ISO 11688-2:2000 also gives useful information concerning noise generation.

6.7.3 The weighted sound pressure emissions level shall be taken in the Operator Cabin with the Main and Auxiliary Service Winches running:

- at idle and the with winch controls in the neutral position;
- at full throttle with and without maximum rated loads.

6.7.4 The maximum allowable noise levels shall not exceed:

- 75 dB(A) at the normal operator position with the cabin door closed;
- 85 dB(A) measured 1 m from the outside of the machine house and from any engine exhaust.

6.8 Electrical and Lighting System

6.8.1 The electrical installation and equipment shall comply with requirements of I-ET-3010.00-5140-700-P4X-001 – Specification for Electrical Design for Offshore Units, I-ET-3010.00-5140-700-P4X-002 – Specification for Electrical Material for Offshore Units, I-ET-3010.00-5140-700-P4X-007 - Specification for Generic Electrical Equipment for Offshore Units, I-ET-3010.00-5140-700-P4X-009 - General Requirements for Electrical Material and Equipment for Offshore Units, I-ET-3010.00-5140-741-P4X-004 - Specification for Low-Voltage Generic Electrical Panel for Offshore Units and

I-ET-3010.00-5140-700-P4X-005 - Requirements for Human Engineering Design for Electrical System of Offshore Units.

6.8.2 Electrical induction motors shall comply with requirements of I-ET-3010.00-5140-712-P4X-001 – Low-Voltage Induction Motors for Offshore Units.

6.8.3 Concerning electrical system voltages and quantity of feeders for motors, panels and auxiliaries shall be according to definitions of I-ET-3010.00-5140-700-P4X-003 – Electrical Requirements for Packages for Offshore Units.

6.8.4 All electrical equipment, instruments and telecommunications equipment shall be manufactured and tested in compliance with Classification Society and IEC requirements.

6.8.5 All electrical equipment, instruments and telecommunications equipment installed in hazardous areas shall be certified according to area classification. All electrical equipment, instruments and telecommunication equipment installed outdoors and kept energized during emergency shutdown ESD-3P or/and ESD-3T shall be certified for installation in hazardous areas Zone 2, Group IIA Temperature Class T3, complying with requirements of IEC 61892 and Classification Society. They shall be of type approved and certified according to certified by international recognized laboratory and also in accordance with INMETRO Resolution 115, March 21st 2022.

6.9 Automation, Control and Instrumentation

6.9.1 The package automation, control and instrumentation shall fully comply with I-ET-3010.00-1350-940-P4X-001 – SYSTEMS OPERATION PHILOSOPHY and I-ET-3010.00-1200-800-P4X-002 – Automation, Control and Instrumentation on Package Units.

6.9.2 PACKAGER/MANUFACTURER shall ensure that the equipment is properly certified for the specified classification. For further information see I-ET-3010.2Q-1200-800-P4X-005 – Field Instrumentation.

6.9.3 PACKAGE automation type classification shall be according to I-ET-3010.2Q-1200-800-P4X-014 – Automation Interface of Packaged Units.

6.9.4 All sensors shall be suitable for prevailing temperatures. When applicable, field amplifiers, transducers, etc., shall be installed as per PACKAGER/MANUFACTURER practices, according to the area classification and to protect them against mechanical damage.

6.9.5 All wiring within the limits of the enclosure shall be clearly marked on the wire and at the terminal.

6.10 Monitoring Requirements, Alarms and Shutdown Signals

6.10.1 Riser Pull-In and Pull-Out System shall be monitored and the monitoring requirements, minimum alarms and shutdown signals & functions shall be according to I-FD-3010.2Q-5400-947-P4X-001 - SAFETY DATA SHEET and FPSO matrix of cause and effect to be approved by OWNER.

6.10.2 All machine monitoring sensors (pressure, temperature, flow, among others) shall be interconnected to the local control console at Operator Cabin. Shutdown signals shall be linked to UNIT´s Control Safety System and visible at UNIT´s Center Control Room.

6.11 Telecommunications Requirements

6.11.1 PACKAGER/MANUFACTURER shall supply a digital VHF base station radio at Operator Cabin with external antenna. Such radio shall be homologated and licensed in Brazilian Telecom Regulatory Agency (ANATEL).

6.11.2 It shall be delivered all documents and forms required to legalize the VHF radio including the payment of the ART (technical responsibility term) to CREA and the signed report according to ANATEL resolution 700 of SEP/28/2018.

6.11.3 PACKAGER/MANUFACTURER shall provide a camera monitoring system in order to allow the winch operator to view the trolley and winches area increasing safety in operation.

6.11.4 The cameras shall be integrated to the Hull CCTV system using the available wi-fi signal from FPSO WLAN system or from structured cabling. For further information, check the referenced documents stated previously on item 4.5.

6.11.5 CCTV system shall operate in a standalone mode. From the monitor inside cabin, it will be possible only to monitor images PACKAGER/MANUFACTURER cameras. However, such images shall be wireless or cabled to be sent to Hull CCTV System to be recorded and presented.

7 NAMEPLATES AND TAG NUMBERING

7.1 Nameplates

7.1.1 MANUFACTURER shall attach corrosion resistant SS 316 nameplates on main equipment and its ancillaries in an accessible location, fastened with corrosion resistant pins.

7.1.2 The nameplate information shall include, as a minimum, the following items in the Portuguese and English language:

- Purchase order
- Manufacturer and year of built
- TAG number
- Equipment model and serial number
- Load capacity
- Dry weight
- Driver power rating and speed
- Design code
- Design temperature and pressure
- NOTE: The nameplate data for equipment, which handle hydrocarbons, shall have information that allows the lost emission calculation, according to established Standards from AP-42 – Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, of the USA Environment Protection Agency (EPA).

7.2 TAG Numbering

7.2.1 PACKAGER/MANUFACTURER shall consider the following TAG numbering:

- GN-5268501: Pull-in Main Winch;
- GN-5268502: Pull-in Auxiliary Service Winch;
- GN-5268504: Pull-in Handling Service Winch;
- Z-5268501: Pull-in Sheave Trolley;
- Z-5268502: Operator Cabin;
- GD-5268501: Pull-in Overhead Crane;
- UH-5268501: Pull-in Main and Auxiliary Service Winch HPU;
- UH-5268502: Pull-in Sheave Trolley HPU or Pull-in Overhead Crane HPU, if necessary.
- Tagging of all items including valves shall be carried out in accordance with I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.

7.2.2 Tags shall be supplied with number and description in Portuguese language.
7.2.3 All tag plates shall be made from SS 316 stainless steel material.
7.2.4 Valves shall be tagged with the applicable number only.
7.2.5 Tag numbers for remaining auxiliary equipment shall be defined in detailed design after approval of OWNER.

8 SPARE PARTS AND SPECIAL TOOLS

8.1 Spare Parts

8.1.1 PACKAGER/MANUFACTURER shall include in the supply of equipment all spares required for installation, commissioning and startup with spare part inventory. For instance: tightening bolts and nuts; hydraulic components; hoses and gaskets; relays.
8.1.2 Spare parts recommended by the Classification Society, if applicable, shall also be provided. Spare parts list recommended for 2 (two) years operation, including price and delivery time of each part shall be provided.
8.1.3 All spares shall be packed separately with clear identification and delivered with the main equipment in packing suitable for long-term storage.
8.1.4 All spare parts shall be detailed in the packing list, and shall be consistent with the list of spare parts issued for the engineering documentation. These items shall have an item number in the packing list, which shall match the item number fixed on the packing.

8.2 Special Tools

8.2.1 MANUFACTURER shall provide any special tools necessary for installation, commissioning, start-up and maintenance of the equipment as alignment templates, spreader bars, lifting beams and specific handling devices.
8.2.2 All special tools shall be supplied with the delivery of the equipment. Special tools and SUPPLIER personnel required for installation and/or commissioning shall be specified as a separate cost.
8.2.3 All special tools shall be detailed in the packing list, and shall be consistent with the list of special tools issued for the engineering documentation. These items shall have an item number in the packing list, which shall match the item number fixed on the packing.

9 INSPECTION, TESTING AND COMMISSIONING

9.1 Classification Society Certification

9.1.1 Classification Society Certificate of compliance with rules requirements shall be supplied for Riser Pull-In and Pull-Out System, including Overhead Crane.
9.1.2 PACKAGER/MANUFACTURER shall be responsible for obtaining all necessary certification of the equipment. PACKAGER/MANUFACTURER through the independent certifying authority shall supply all certificates related to the materials, as wire rope and socket certificates, qualification activities, inspections and tests detailed in the approved Quality Plan.
9.1.3 All materials and equipment shall be according to the Classification Society Rules, Flag State Requirements and Brazilian Coastal Authority (DPC) Regulations. Classification Society shall provide guidance and obtain the interpretations from Flag State and DPC requirements, if necessary.
9.1.4 For qualification activities, inspection and testing, Classification Society shall be consulted to define the requirements applicable to the Riser Pull-In and Pull-Out System.

9.2 Inspection and Testing

9.2.1 PACKAGER/MANUFACTURER shall prepare the Inspection and Test Plan (ITP) and submit it for OWNER approval. The equipment and its associated components shall be inspected and tested

to verify proper form, fittings, dimensions and function before shipment to the SUPPLIER at integration site.

9.2.2 Inspection requirements shall follow the Exhibit V (DIRECTIVES FOR PROCUREMENT) and Exhibit VII (DIRECTIVES FOR QUALITY MANAGEMENT SYSTEM).

9.2.3 PACKAGER/MANUFACTURER shall ensure that all the witnessed inspection requirements by the Classification Society are fully accommodated and the due notice requirements are satisfied. OWNER shall witness hydrostatic test of vessels classified as NR-13.

9.3 Factory Acceptance Test (FAT)

9.3.1 PACKAGER/MANUFACTURER shall prepare the FAT procedure and submit it for OWNER approval prior to the tests. FAT procedures shall include sketches, showing the operation step by step. It shall be carried out in accordance with this technical specification.

9.3.2 PACKAGER/MANUFACTURER shall advise OWNER of the test schedule before the planned test dates. When required, PACKAGER/MANUFACTURER shall arrange with the appointed Classification Society surveyor to witness FAT.

9.3.3 PACKAGER/MANUFACTURER shall make preliminary test to ensure that all parts of the equipment are operating satisfactorily prior to the arrival of the OWNER's representative.

9.3.4 If it is found necessary to dismantle any equipment during a test, because of malfunction, the test may then be invalidated, and a full test shall be required after the repair of the fault.

9.3.5 Acceptance of FAT will not be considered as the final acceptance of the equipment and shall not relieve the PACKAGER/MANUFACTURER of his responsibilities in any way whatsoever.

9.3.6 **Required Tests:**

- Main Winch functional and full load test;
- Auxiliary Service Winch functional and full load test;
- Sheave Trolley functional and full load test of vertical pivoting sheave and service sheaves.
- Handling Service Winch functional and full load test;
- Operator Cabin functional test and control console integration test;
- Overhead Crane functional test and full load test;
- Hydraulic Power Unit functional test;
- Full load test shall be according to this technical specification and Classification Society rules.
- Classification Society additional tests according to their specific rules.

9.4 Commissioning

9.4.1 PACKAGER/MANUFACTURER shall be required to provide any necessary installation support like assembly, pre-commissioning and commissioning supervision of the equipment and of the components delivered loose either at a shore based fabrication yard and/or on the UNIT.

9.4.2 Commissioning requirements shall follow the Exhibit V (DIRECTIVES FOR PROCUREMENT), Exhibit VIII (DIRECTIVES FOR COMMISSIONING PROCESS) and its Appendix 1 with the conditions for acceptance and approval for performance test of the UNIT.

9.4.3 SUPPLIER shall inform PACKAGER/MANUFACTURER regarding specific commissioning conditions for the equipment, i.e., conditions in which the equipment will have to operate temporarily, which are different from the conditions defined in this technical specification.

9.5 Site Acceptance Tests (SAT)

9.5.1 SUPPLIER shall prepare the SAT procedure and submit it for OWNER approval prior to the tests. SAT procedures shall include sketches, showing the operation step by step. It shall include system

checks, functional and performance verifications such as monitoring measurements, alarms and safety checks, brake and load tests, for example.

9.5.2 SUPPLIER shall advise PACKAGER/MANUFACTURER of the test schedule before the planned test dates. When required, SUPPLIER shall arrange with the appointed Classification Society surveyor to witness SAT.

9.5.3 If it is found necessary to dismantle any equipment during a test, because of malfunction, the test may then be invalidated, and a full test shall be required after the repair of the fault.

9.5.4 HULL SUPPLIER shall foresee at least one anchor point or more to allow execution of all minimum required tests. Main and service wire ropes shall be fixed on anchor points installed at Upper Riser Balcony (URB) or Lower Riser Balcony (LRB)

9.5.5 **Minimum Required Tests:**

- Main Winch functional and load test with 70% of rated pulling capacity;
- Auxiliary Service Winch functional and load test with 70% of rated pulling capacity;
- Sheave Trolley functional and load test of vertical pivoting sheave and service sheaves.
- Sheave Trolley shall be moved alongside all Riser Pull-in Structure (RPS) and its locking pins shall be tested in all Upper I-Tubes positions.
- Handling Service Winch functional and load test with 70% of rated pulling capacity;
- Operator Cabin functional test and control console integration test;
- Overhead Crane functional and running test with 70% of rated capacity during 2 hours;
- Hydraulic Power Unit functional test;
- Classification Society additional tests according to their specific rules.

9.5.6 **Full Load Test:**

- Full load test at integration site can be replaced by strength analysis, if agreed and formally accepted by Classification Society. Strength analysis of Pull-in and Pull-out System equipment and Riser Pull-in Structure (RPS) is mandatory. It shall be demonstrated through element finite analysis, calculations and material specifications.
- If required by Classification Society, full load test shall be performed at integration site, according to their specific rules. Full load of all winches and sheaves installed onboard the FPSO maybe required by Classification Society.
- Full load tests procedures for each set of winch and sheave shall be submitted to OWNER approval prior to the tests. These procedures shall include sketches, showing the operation step by step. Classification Society and OWNER representative shall witness full load test for final approval.

9.5.7 **Hydraulic Power Unit Functional Test:**

- The fully assembled Hydraulic Power Unit shall be tested to verify the operation of the motors, pumps and the correct assembling of piping, hoses, valve manifolds and instruments. It shall be checked hydraulic oil tank tightness and hydraulic oil cleanliness (NAS).
- A flow vs. pressure diagram shall be plotted for each assembled motor pump to verify the performance and settings. All valves, gauges and indicators shall be factory set and calibrated.
- Tests shall cover at least the following factors: tightness/leakage; hydraulic/pneumatic/electrical continuity; electrical isolation; electrical noise immunity; and adherence of paintwork.
- An additional running test shall be performed at shipyard, keeping all HPU in continuous operation during 24 hours (no load on the winches) in order to check cooling system, motor superheating and oil leakage.

10 TECHNICAL ASSISTANCE, TRAINING AND WARRANT

10.1 PACKAGER/MANUFACTURER shall provide technical assistance during assembly, installation, pre-commissioning, commissioning and start-up phases and a complete training program for OWNER engineering, operation and maintenance team.

10.2 Technical assistance, training and warranty requirements shall follow the Exhibit V (DIRECTIVES FOR PROCUREMENT) and Exhibit VIII (DIRECTIVES FOR COMMISSIONING PROCESS). The applicable services shall be considered by SUPPLIER.

11 PREPARATION FOR SHIPMENT

11.1 Marking

11.1.1 All items supplied to this specification shall be adequately marked for identification against a certificate or relevant test documentation. Marking shall be such that it shall not damage or impair the component. Marking may be done on the item itself or on its packing or nameplate.

11.1.2 Items that cannot be identified shall be rejected. Rejected items may be recertified by carrying out all relevant testing, with prior approval of the SUPPLIER.

11.1.3 As a minimum, the following identification shall be provided:

- Project number;
- Manufacturer's name;
- Purchase order number;
- Shipping weight;
- Item number;
- Classification Society surveyor's stamp.

11.2 Shipment Packing

11.2.1 The equipment shall be supplied tested, flushed and preserved and, if practical, already charged up with coolant and lubricants.

11.2.2 The preparation shall make the equipment suitable for 12 months outdoor storage from the time of shipment. The package shall be protected from corrosion.

11.2.3 PACKAGER/MANUFACTURER shall submit the packing specification to the SUPPLIER for approval. Packing shall be in accordance with the requirements of the country to which the equipment is being shipped.

11.2.4 PACKAGER/MANUFACTURER shall provide the procedures for unpacking, handling and installation, as well as repacking, and long-term storage requirements. PACKAGER/MANUFACTURER shall specify any limitations applicable to the transport and installation phase.

11.2.5 Unless otherwise advised, each item of equipment shall be checked for its suitability to resist horizontal and vertical acceleration of 0.8g in any direction during sea transportation.

12 DOCUMENTATION REQUIREMENTS

12.1 The following documents shall be provided during technical proposal by PACKAGER/MANUFACTURER in their preliminary version:

- General Arrangement Drawing;
- Equipment Data Sheet.

12.2 After PACKAGER/MANUFACTURER has been chosen, during detail engineering design, PACKAGER/MANUFACTURER shall issue before any other documents the document list.

12.3 Document list shall be approved before issuance of any other document from PACKAGER/ MANUFACTURER. The reason for this requirement is to avoid issuance of documents with wrong document number, which will require document cancellation procedure to be followed.

12.4 Title of all documents to be issued by PACKAGER/MANUFACTURER shall have the following format:

- First part – tag number;
- Second part – service description;
- Third part – document description;
- EXAMPLE: GN-5268501 – Pull-in Main Winch – Data Sheet.

12.5 PACKAGER/MANUFACTURER shall provide original documents in PDF format for all required documents. Extracted figures from catalogue or manual, especially for the outline drawings are not acceptable.

12.6 PACKAGER/MANUFACTURER shall provide a full 3D model of the equipment in format ISO 14306:2017 (*.jt), ACIS (*.sat) or Microstation V8 (*.dgn) or in format STEP (ISO10303 Standard for Exchange of Product model data or equivalent).

12.7 After document list is approved, the following table defines the minimum set of technical documents required to be issued by PACKAGER/MANUFACTURER:

DESCRIPTION
Document list
Fabrication schedule (1)
Progress report (1)
General arrangement drawing
Cross section drawing with part list
Equipment datasheet
Weight / center of gravity datasheet
Winch load calculation sheet
Ancillary equipment datasheet (2)
Ancillary equipment outline drawing (2)
Painting and insulation specification
Noise datasheet
Noise report
Nameplate drawing
HMI screen layout
Cause and effect chart
Set points, alarms and shutdown list
Instrument and instrumented valves list (3)
Instrument and instrumented valves datasheet
Control valves, PSVs and flowmeters calculation sheet
Piping and instrumentation diagram
Hydraulic diagram
Logic diagram (4)
Loop diagram (4)
Interconnection wiring diagram (4)
Electromechanical panel drawing (4)
Automation architecture (4)
I/O list
Quality plan
Inspection and test plan
FAT procedure
Installation, commissioning, operation and maintenance manual
Sub-assembly drawing
Erection and installation procedure
Lifting arrangement drawing
Pre-commissioning and commissioning procedure
SAT procedure (4)
Utilities consumption list (5)
Sub-suppliers list
Recommended installation, commissioning and start-up spares list
Recommended two years operating spare part list
Special tools list
Packing list
Packing, shipping and preservation procedure
Databook index
Databook
Ancillary equipment catalogues
Material traceability records
Material certificates
Heat treatment records
NDT records (6)
Manufacture deviation records

Wire rope and auxiliary lifting equipment certificates
Hazardous area equipment certificates
Instruments calibration certificates
Hydrotest reports
NR-13 documentation
Classification Society Certificate of Compliance

NOTES:
1. To be issued periodically, in accordance with total duration of the fabrication time (e.g., every two weeks or every month).
2. PACKAGER/MANUFACTURER may choose to include equipment data within the outline drawing, if quantity of relevant data does not exceed 10 items.
3. For packages with more than 10 instruments.
4. Documentation may be issued by PACKAGER/MANUFACTURER. Otherwise, the information shall be included in the documentation issued by SUPPLIER.
5. All utilities shall be included, as for example, instrument and / or service air, cooling water and electrical loads, among others.
6. NDT records to be included in the databook shall be in conformance with all tests and inspection activities defined on the Inspection and Test Plan.

12.8 The hydraulic diagram shall contain the description of the hydraulic circuits, explaining the function of the main components, including actuation and equipment protection.

12.9 PACKAGER/MANUFACTURER may choose to issue one single manual with installation, commissioning, operation and maintenance procedures or split manuals with specific procedures.

12.10 Installation manual shall contain instructions to assemble and disassemble each major piece of the equipment and all recommendations for preservation during storage on erection stage.

12.11 If PACKAGER/MANUFACTURER fails to provide the manual with this information, any damages due to the lack of preservation will be PACKAGER/MANUFACTURER's responsibility.

12.12 Installation manual shall also contain all consumables to be used for erection, commissioning and start up, preferably in a summarized list.

12.13 Operation manual shall contain, among other information, the load chart, safety alerts and local control console description.

12.14 Maintenance manual shall contain the specification of hydraulic oil and lubricant fluids with periodicity of replacement. It shall be presented the recommended two years operating spare part list.

12.15 Ancillary equipment, such as gearboxes, hydraulic motors, brakes, pumps, motor pumps and others hydraulic major components, catalogues shall be word searchable (not image doc).

12.16 Each material certificate and NDT report provided by third parties shall be preceded by a PACKAGER/MANUFACTURER sheet, informing to which part of the equipment the document refers.

13 PULL-IN AND PULL-OUT SYSTEM REQUIREMENTS

13.1 Main Winch

13.1.1 Main Winch shall be installed on the FWD end of Riser Pull-in Structure (RPS) and it shall comply with the following requirements:

13.1.2 **Type:**

- Fixed electro-hydraulic rotary drum winch.

13.1.3 **Function:**

- Pull-in and pull-out operation.
- Installation and uninstall of flexible and umbilical risers.

13.1.4 **Performance Requirements:**

- Rated pulling capacity, SWL: 4,904kN (500tf) on top layer.

- Pull-in and pull-out capacity shall allow invert the winch direction, regardless the layer, for example.
- The full load test shall be 10% beyond the rated pulling capacity, SWL.
- Maximum pulling capacity, stall: 5,394kN (550tf).
- Minimum static brake capacity: 6,473kN (660tf).
- Parking/emergency brake capacity: 6,472kN (660tf).
- The brakes capacity shall be 1.32 times the rated pulling capacity, SWL.
- Minimum speed: 4m/min at 2,452kN (top layer) and
  2m/min at 4,904kN (top layer).
- PACKAGER/MANUFACTURER shall define maximum speed at zero load.

13.1.5 **Functional Requirements:**

- The winch shall be designed considering weather stand-by during pull-in operation when it is necessary pay-in or pay-out 1m of riser every 6h.
- The winch shall be capable of pull-in and pull-out under any load, in automatic and manual mode, in a continuous operation.
- The total number of winch system driven, as gearboxes, hydraulic motors and brakes, shall be optimized according to design possibilities. For same capacity winches, they are traditionally supplied with 5 system driven. The final solution shall be SUPPLIER scope of work and it shall be approved by OWNER.
- For each system drive, it shall be provided sensors to monitor pressure. It is also required measure temperature at pressure lines and flow rate at motors drain.
- The winch shall be provided with variable speed control to assure good performance with high load in very low speed. It shall be provided a safety interlock which shall not allow change the speed during pull-in and pull-out operation, from low speed to high speed mode, with winch loaded, even in case the operator change the speed selector.
- The winch material shall be selected for outdoor installation, with suitable marine treatment.
- The winch shall have a single support frame, baseplate with drip pans and drains where necessary.
- Means to avoid oil draining through the return lines shall be provided due to the difference height of pull-in winches and HPU. Siphon or spring loaded check-valves are acceptable and shall be provided by PACKAGER/MANUFACTURER.
- The winch shall be provided with devices or mechanisms to allow adequate maintenance of the main parts with no crane assistance.

13.1.6 **Drum and Wire Rope Requirements:**

- The drum shall be LEBUS grooved type in order to store one wire rope.
- Minimum drum diameter shall be 20 times the wire rope nominal diameter.
- Minimum sheave diameter shall be 20 times the wire rope diameter.
- The wire rope shall be galvanized, rotation-resistant, right hand Lang's lay, full plastic coating of IWRC, compacted strands, abrasion resistant and resistant to drum crushing, 1960 or 2060 N/mm2 grade, with closed spelter socket at working end, heavy duty lubrication, crushing and bending fatigue resistant, or equivalent and MBL 13,485kN (1,375tf = 2.5x maximum pulling capacity).
- The minimum wire rope length shall be 1,100m. This length does not include any dead turn.
- SUPPLIER shall define the total wire rope length with a minimum of three dead turns on the drum at detailed design phase. It shall be provided by SUPPLIER and informed to PACKAGER/MANUFACTURER.
- The anchorage of the wire rope to the drum including dead turns shall have strength not less than 80% of the MBL´s wire rope.
- The wire rope shall be furnished with closed spelter socket CROSBY type or similar.
- An automatic spooling device shall enable smooth spooling-on of the wire rope onto the drum. It shall be mounted on the pull-in system structure. The spooling device and winch drives shall have a safety distance to avoid interference in during operation.
- Regarding spooling device mechanism, it is acceptable diamond shaft-screw level winder and self reversing-lead screw level winder. Shaft grooves cannot be a barrier for screw and pawl displacement. It is also acceptable spooling device mechanism guided by hydraulic cylinder provided an efficient synchronism.
- The winch shall be provided with a fix wire rope lubrication system.
- HULL SUPPLIER shall be provided fresh water facility that will be used to wash the main wire rope.

- The winch shall be delivered at site with wire rope already spooled and pre-tensioned for pull-in operation.

13.1.7 **Winch Braking Requirements:**

- The winch drum shall be capable of being braked at all load levels.
- The brake shall be automatically released by pressure from the HPU at pull-in or pull-out, i.e. at normal operation.
- The brake shall automatically engage when pull-in or pull-out has stopped, i.e. speed control in neutral position.
- The winch drum shall be automatically braked in events of hydraulic power failure.
- The winch drum system shall have additional release stand-alone system by stored energy, which will enable the brake to be released in a controller manner in events of hydraulic power failure.
- PACKAGER/MANUFACTURER shall consider at parking/emergency brake design the dynamic loads at least for 3 months of continuous usage of these brake.
- The winch parking/emergency brake design shall consider a ratchet & pawl system hydraulically operated with proximity switches. In case of hydraulic system failure, the pawl can still be engaged by using hand pump to manually actuate the cylinder. An alternative solution can be evaluated provided that it enables replacing winch brakes at the same time the equipment is holding the load.
- The hydraulic system shall be developed in order to temporarily maintain the pressure on the brakes until the dynamic movement of the winch has definitively stopped, and then after the full stop the parking brakes can act. It shall guarantee brake synchronism, avoiding a “crash stop” on pull-in winch due to inertial movement.
- The pressure line shall be supplied with counterbalance valves in order to enable the synchronism between motor start-up and brake release as well brake engage and motor shutdown.
- It is not allowed hydraulic system with closed circuit (bidirectional pumps), it is only allowed open circuit (one direction pumps). It is not also allowed shuttle/flushing valves coupled at the motors, they shall be installed at pressure lines.
- The pressure line shall be supplied with a proportional lever control to allow a hydraulic ramp and smoothly movement of the winch (soft shift for mitigating winch high inertia problems).

13.1.8 **Winch Monitoring Requirements:**

- The winch shall be provided with independent monitoring system and winch control system, both incorporated in a local control console at Operator Cabin.
- The winch monitoring system shall have the following function and information:
  - Equipment schematic layout;
  - Real time measurements;
  - Incoming alarms an fault detection;
  - Data logging, event/variable recording and storing.
- The winch monitoring system shall be capable of detecting components defects and anticipating equipment failure with sufficient lead-time to permit predictive maintenance and reduce operation outages.
- All data shall be exportable in a retrievable file format trough network or using 3.0 stick.
- The local control console shall have Human Machine Interface screen and analog display, if required.
- The local control console shall have the following function and information:
  - Load cell tension reading, including overload alarm;
  - Winch speed, including overspeed alarm;
  - Payout length in a digital and analog display;
  - Winch operating/running hours;
  - Pressure readings, including high and low pressure alarm;
  - Temperature readings, including hydraulic oil tank high temperature alarm;
  - Speed selector;
  - Electronic joystick;
  - Winch parking/emergency locking device switch and position status;
  - Emergency shutdown button.
- The overload alarm shall consider the tension, speed, payout length and pressure as established at load chart.

- Whenever a preset high pressure or preset low pressure is measured, the winch system shall be capable of stopping automatically the flow by closing a shutdown valve, turning off pumps and starting a deviation flow. It is necessary to avoid any type of spillage during pull-in and pull-out operations.
- The local control console shall provide safety interlocks for overload, overspeed, pressure and temperature. It shall unable the equipment start-up in case of failure of one or more system drive. It shall detect components, such as gearboxes, hydraulic motors and brakes, failure.
- It shall be provided a safety interlock which shall not allow change the speed during pull-in and pull-out operation, from low speed to high speed mode, with winch loaded, even in case the operator change the speed selector.
- Interlocks shall be inserted at Programmable Logic Controller (PLC).
- The emergency shutdown signal is required on the UNIT´s Center Control Room.

13.2 Auxiliary Service Winch

13.2.1 Auxiliary Service Winch shall be installed on the AFT end of Riser Pull-in Structure (RPS) and it shall comply with the following requirements:

13.2.2 **Type:**

- Fixed electro-hydraulic rotary drum winch.

13.2.3 **Function:**

- Assistance of pull-in and pull-out operation.
- Cargo handling and equipment positioning.
- Handling and positioning of marine materials, riser and piping accessories, as transfer rigging, A&R wire rope, pull-heads, hang-off colars, top interface spools, mockups and shutdown valves (SDV), including assembling and disassembling of these materials at Upper Riser Balcony.
- Auxiliary Service Winch shall assist handling activities below Riser Pull-in Structure (RPS) during pull-in at Lower Riser Balcony or underwater to recover PipeLay Vessel – PLV main (A/R) wire rope during pull-out operation, for example.

13.2.4 **Performance Requirements:**

- Minimum rated pulling capacity, SWL: 393kN (40tf) on top layer.
- The full load test shall be 25% beyond the rated pulling capacity, SWL.
- Maximum pulling capacity, stall: 491kN (50tf).
- Minimum static brake capacity: 589kN (60tf).
- Parking/emergency brake capacity: 589kN (60tf).
- The brake capacity shall be 1.5 times the rated pulling capacity, SWL.
- Minimum speed at rated pulling capacity: 6m/min at 393kN (top layer).

13.2.5 **Functional Requirements:**

- The winch shall be capable of assist pull-in and pull-out under any load, in automatic and manual mode, in a continuous operation.
- The total number of winch system driven, as gearboxes, hydraulic motors and brakes, shall be optimized according to design possibilities.
- For each system drive, it shall be provided sensors to monitor pressure. It is also required measure temperature at pressure lines and flow rate at motors drain.
- The winch shall be provided with variable speed control to assure good performance with high load in very low speed. It shall be provided a safety interlock which shall not allow change the speed during pull-in and pull-out operation, from low speed to high speed mode, with winch loaded, even in case the operator change the speed selector.
- The winch shall be provided with suitable marine treatment.
- The winch shall have a single support frame, baseplate with drip pans and drains where necessary.
- Means to avoid oil draining through the return lines shall be provided due to the difference height of pull-in winches and HPU. Siphon or spring loaded check-valves are acceptable and shall be provided by PACKAGER/MANUFACTURER.
- It shall also have trays to collect cables and hoses suitable for the entire length of the riser balcony.
- The winch shall be provided with devices or mechanisms to allow adequate maintenance of the main parts with no crane assistance.

13.2.6 **Drum and Wire Rope Requirements:**

- The drum shall be LEBUS grooved type in order to store one wire rope.
- Minimum drum diameter shall be 20 times the wire rope nominal diameter.
- The wire rope shall be galvanized, low rotation, right hand Lang's, full plastic coating of IWRC, compacted strands, abrasion resistant and resistant to drum crushing, 1960 N/mm^2 grade, with closed spelter socket at working end, heavy duty lubrication, crushing and bending fatigue resistant, or equivalent and MBL 981kN (100tf = 2x maximum pulling capacity).
- The wire rope length shall be 800m. This length does not include any dead turn.
- PACKAGER/MANUFACTURER shall define total length with a minimum of three dead turns on the drum.
- The anchorage of the wire rope to the drum including dead turns shall have strength not less than 80% of the MBL´s wire rope.
- The wire rope shall be furnished with closed spelter socket CROSBY type or similar.
- This closed spelter sockets will be connected to pull-in rigging. The pull-in rigging and its underwater connection to the riser, might include a Dyneema (HMPE) sling that can be easily handled by ROV manipulators. Rigging and ROV are not MANUFACTURER scope of supply.
- An automatic spooling device shall enable smooth spooling-on of the wire rope onto the drum. It shall be mounted on the pull-in system structure. The spooling device and winch drives shall have a safety distance to avoid interference during operation.
- Regarding spooling device mechanism, it is acceptable diamond shaft-screw level winder and self reversing-lead screw level winder. Shaft grooves cannot be a barrier for screw and pawl displacement. It is also acceptable spooling device mechanism guided by hydraulic cylinder provided an efficient synchronism.
- The winch shall be provided with a fix wire rope lubrication system.
- HULL SUPPLIER shall be provided fresh water facility that will be used to wash the main wire rope.
- The winch shall be delivered at site with wire rope already spooled and pre-tensioned for pull-in operation.

13.2.7 **Winch Braking Requirements:**

- The winch drum shall be capable of being braked at all load levels.
- The brake shall be automatically released by pressure from the HPU at pull-in or pull-out, i.e. at normal operation.
- The brake shall automatically engage when pull-in or pull-out has stopped, i.e. speed control in neutral position.
- The winch drum shall be automatically braked in events of hydraulic power failure.
- The winch drum system shall have additional release stand-alone system by stored energy, which will enable the brake to be released in a controller manner in events of hydraulic power failure.
- PACKAGER/MANUFACTURER shall consider at parking/emergency brake design the dynamic loads at least for 3 months of continuous usage of these brake.
- The winch parking/emergency brake design shall consider a ratchet & pawl system hydraulically operated with proximity switches. In case of hydraulic system failure, the pawl can still be engaged by using hand pump to manually actuate the cylinder. An alternative solution can be evaluated provided that it enables replacing winch brakes at the same time the equipment is holding the load.
- The hydraulic system shall be developed in order to temporarily maintain the pressure on the brakes until the dynamic movement of the winch has definitively stopped, and then after the full stop the parking brakes can act. It shall guarantee brake synchronism, avoiding a "crash stop" on pull-in winch due to inertial movement.
- The pressure line shall be supplied with counterbalance valves in order to enable the synchronism between motor start-up and brake release as well brake engage and motor shutdown.
- It is not allowed hydraulic system with closed circuit (bidirectional pumps), it is only allowed open circuit (one direction pumps). It is not also allowed shuttle/flushing valves coupled at the motors, they shall be installed at pressure lines.
- The pressure line shall be supplied with a proportional lever control to allow a hydraulic ramp and smoothly movement of the winch (soft shift for mitigating winch high inertia problems).

13.2.8 **Winch Monitoring Requirements:**

- The winch shall be provided with independent monitoring system and winch control system, both incorporated in a local control console at Operator Cabin.

- The winch monitoring system and the local control console shall have the following function and information:
  - Load cell tension reading, including overload alarm;
  - Winch speed, including overspeed alarm;
  - Payout length in a digital and analog display;
  - Winch operating/running hours;
  - Pressure readings, including high and low pressure alarm;
  - Temperature readings, including hydraulic oil tank high temperature alarm;
  - Speed selector;
  - Electronic joystick;
  - Winch parking/emergency locking device switch and position status;
  - Emergency shutdown button.
- The overload alarm shall consider the tension, speed, payout length and pressure as established at load chart.
- Whenever a preset high pressure or preset low pressure is measured, the winch system shall be capable of stopping automatically the flow by closing a shutdown valve, turning off pumps and starting a deviation flow. It is necessary to avoid any type of spillage during pull-in and pull-out operations.
- The local control console shall provide safety interlocks for overload, overspeed, pressure and temperature. It shall unable the equipment start-up in case of failure of one or more system drive. It shall detect components, such as gearboxes, hydraulic motors and brakes, failure.
- It shall be provided a safety interlock which shall not allow change the speed during pull-in and pull-out operation, from low speed to high speed mode, with winch loaded, even in case the operator change the speed selector.
- Interlocks shall be inserted at Programmable Logic Controller (PLC).
- It is desirable constant tension function.
- The emergency shutdown signal is required on the UNIT´s Center Control Room.

13.3 Operator Cabin

13.3.1 The Operator Cabin shall be located at Riser Pull-in Structure (RPS), preferably installed at FWD end of Riser Pull-in Structure (RPS).

13.3.2 **Function:**

- Operate Main and Auxiliary Service Winches, Sheave Trolley and Handling Service Winch.

13.3.3 **Functional Requirements:**

- Operator Cabin shall have VHF fix radio.
- It shall be provided a good and full visibility of the winches with camera monitoring system and lighting system, especially, for checking wire rope spooling and routing through Sheave Trolley.
- Operator Cabin shall be integrated with at least 02 (two) cameras to monitor FWD and AFT winches and 02 (two) cameras at Sheave Trolley to allow operator view the pull-in and pull-out operation.
- Cameras shall be for protected in explosion proof housing with damping and designed for a marine environment. They shall be certified for hazardous areas, Zone-II, Ex-d, Group IIC, T4.
- One of the cameras shall be mounted on a magnetic base, so that it can be positioned underneath the Sheave Trolley and maintain a steady view during pull-in and pull-out operation.
- The split color monitor shall be connected with CCTV system camera for narrow-angle/distant-focus and monitor size at least 10in (254mm).
- Operator Cabin shall be supplied with air conditioning and termo-acoustic insulation.

13.4 Sheave Trolley

13.4.1 Sheave Trolley shall be installed on Riser Pull-in Structure (RPS) and it shall comply with the following requirements.

13.4.2 **Function:**

- Place the vertical sheaves on the top of Upper I-Tubes along the Upper Riser Balcony, enabling pull-in and pull-out operations through different I-Tubes positions.

13.4.3 **Design Requirements:**

- Sheave Trolley shall be supported by Riser Pull-in Structure (RPS) structure and these supports shall be aligned with the hull webframes in the middle distance between hull webframes.
- Maximum vertical reaction on each point of support shall be 4,000kN and the maximum total vertical reaction on each transverse line of supports shall be 8,000kN.
- The distance between the centerline of the rails is 4.960m and Sheave Trolley locking mechanism shall be installed external to rails.
- Sheave Trolley shall have the following components:
  Trolley platform for sheaves maintenance access;
  Horizontal deviation sheave;
  Vertical pivoting sheave for pull-in and pull-out operation;
  Auxiliary sheave for assistance of pull-in and pull-out operation;
  Handling Service Winch for assistance of pull-in and pull-out operation;
  Handling service sheaves for assistance of flexible riser operation and hoist rigging;
  Hydraulic skidding;
  Drag chains.
- The arrangement of Sheave Trolley shown at Figure 6 and the number of sheaves can be modified provided that SUPPLIER assures the system functionality. These modifications shall be approved by OWNER.
- Sheave Trolley will pass through hazardous areas and it shall have non-sparking construction and materials according to the classification of their respective locations.

13.4.4 **Functional Requirements:**

- PACKAGER/MANUFACTURER shall provide an opening on the trolley floor to allow main and service wire ropes simultaneous downward access to Upper I-Tube.
- The trolley movement shall be in steps to enable the correct alignment above the desired Upper I-Tube.
- The trolley shall have parking brakes to secure the correct positioning and to prevent any unintended motion of the trolley.
- The hydraulic skidding cylinder shall operate in both rails.
- PACKAGER/MANUFACTURER shall define the hydraulic skidding speed.
- The trolley shall be driven over a track system provided by SUPPLIER.
- Electrical power shall be supplied to the trolley through a cable drag chain system or similar.
- It shall have an efficient electric cable guide system for preventing cable kink.
- The trolley shall have drip pans and drains where necessary.
- It shall also have trays to collect cables and hoses suitable for the entire length of the riser balcony.
- Grating floor shall be according to I-DE-3010.00-1400-140-P4X-004 - GENERAL NOTES FOR TOPSIDES STRUCTURES.
- PACKAGER/MANUFACTURER shall foresee access to allow trolley maintenance.
- To easier maintenance access, trolley guardrail shall be dismountable and complying with I-DE-3010.00-1400-140-P4X-003 - STANDARD-STEEL GUARDRAIL - TYPICAL DETAILS and I-DE-3010.00-1400-140-P4X-011 - STANDARD-PULTRUDED GUARDRAIL - TYPICAL DETAILS.
- All trolley components as lights, cameras and horns shall be installed avoiding dropping risks with an efficient secondary anchorage system using stainless steel wire ropes and nets.

13.4.5 **Trolley Monitoring Requirements:**

- The trolley shall be provided with independent monitoring system and winch control system, both incorporated in a local control console at Operator Cabin.
- The trolley monitoring system and the local control console shall have the following function and information:
  - Trolley parking brake locking pins switch and position status;
  - Electronic joystick.
- After pre startup checks and startup of the HPU, the trolley shall be moved front and back via electronic joystick control from the Operator Cabin.

13.5 Horizontal Deviation Sheave, Vertical Pivoting Sheave and Auxiliary Sheave

13.5.1 Horizontal Deviation Sheave, Vertical Pivoting Sheave and Auxiliary Sheave shall be installed on the Sheave Trolley and they shall comply with the following requirements:

13.5.2 **Function:**

- The horizontal deviation sheave shall direct main wire rope until vertical pivoting sheave.
- The vertical pivoting sheave shall direct main wire rope through the Upper I-Tubes during riser pull-in and pull-out operation.
- The auxiliary sheave shall direct service wire rope through the Upper I-Tubes during riser pull-in and pull-out operation.

13.5.3 **Functional Requirements:**

- Sheave wheel and support structure shall be designed to withstand the respective winch load (maximum pulling capacity, stall) with the respective wrapping angles, without any permanent deformation.
- Sheave diameter and groove shall be compatible with the wire rope diameter. The hardness of the sheave grooves shall be enough to avoid early wear of the steel material due to the friction caused by the wire rope under full load.
- Sheave root diameter shall be minimum of 20 times the nominal diameter of the wire rope. The sheave groove shall be machined to properly support the specified wire rope and be flame resist wear.
- Sheaves shall be designed with securing pins to prevent the wire ropes to come out of the sheave when in slack configuration. Sheave design shall enable the wire rope socket passing through it.
- Sheave bearings shall be sized in accordance with winch loads and considering the relationship between working load and bearing service. All bearings shall be provided with grease nipples.
- It is also required a locking system for vertical pivoting sheave and its sliding base.

13.6 Handling Service Winch

13.6.1 Handling Service Winch shall be installed at AFT side of Sheave Trolley and it shall comply with the following requirements:

13.6.2 **Type:**

- Electro-hydraulic rotary drum winch.

13.6.3 **Function:**

- Assistance of pull-in and pull-out pre-operation activities
- Installation and uninstall of main and service wire ropes, including their connection to Sheave Trolley, assembling and disassembling of sockets and hooks, if necessary.
- Handling Service Winch shall assist Sheave Trolley set-up, passing the pull-in wire ropes through the sheaves and passing the main wire socket through the exit turndown sheaves, as well as handle and retrieve of pull-in and pull-out riggings underwater.

13.6.4 **Performance Requirements:**

- Minimum rated pulling capacity, SWL: 197kN (20tf) on top layer.
- The full load test shall be 25% beyond the rated pulling capacity, SWL.
- Maximum pulling capacity, stall: 246kN (25tf).
- Minimum static brake capacity: 295kN (30tf).
- The brake capacity shall be 1.5 times the rated pulling capacity, SWL.
- Minimum speed at rated pulling capacity: 6m/min at 197kN (top layer).

13.6.5 **Functional Requirements:**

- The winch shall be capable of execute services under any load, in automatic and manual mode, in a continuous operation.
- If necessary, the winch shall be provided with variable speed control to assure good performance when tugging and at pull-out services.
- The winch shall be provided with suitable marine treatment.

- The winch shall have a single support frame, baseplate with drip pans and drains where necessary.
- Means to avoid oil draining through the return lines shall be provided due to the difference height of Handling Service Winch and HPU. Siphon or spring loaded check-valves are acceptable and shall be provided by PACKAGER/MANUFACTURER.
- The winch shall be provided with devices or mechanisms to allow adequate maintenance of the main parts with no crane assistance.

13.6.6 **Drum and Wire Rope Requirements:**

- The drum shall be LEBUS type in order to store one wire rope.
- Minimum drum diameter shall be 20 times the wire rope nominal diameter.
- The wire rope shall be galvanized, low rotation, right hand Lang's, full plastic coating of IWRC, compacted strands, abrasion resistant and resistant to drum crushing, 1960 N/mm^2 grade, with closed spelter socket at working end, heavy duty lubrication, crushing and bending fatigue resistant, or equivalent and MBL 491kN (50tf = 2x maximum pulling capacity).
- The wire rope length shall be 300m. This length does not include any dead turn.
- PACKAGER/MANUFACTURER shall define total length with a minimum of three dead turns on the drum.
- The anchorage of the wire rope to the drum including dead turns shall have strength not less than 80% of the MBL´s wire rope.
- The wire rope shall be furnished with closed spelter socket CROSBY type or similar.
- The winch shall have an efficient rope guide system for preventing the rope overlapping in the winding.
- The winch shall be delivered at site with wire rope already spooled and pre-tensioned for pull-in operation.

13.6.7 **Winch Braking Requirements:**

- The winch drum shall be capable of being braked at all load levels.
- The brake shall be automatically released by pressure from the HPU at pull-in or pull-out, i.e. at normal operation.
- The brake shall automatically engage when pull-in or pull-out has stopped, i.e. speed control in neutral position.
- The winch drum shall be automatically braked in events of hydraulic power failure.
- The winch drum system shall have additional release stand-alone system by stored energy, which will enable the brake to be released in a controller manner in events of hydraulic power failure.

13.6.8 **Winch Monitoring Requirements:**

- The winch shall be provided with independent monitoring system and winch control system, both incorporated in a local control console at Operator Cabin.
- The winch monitoring system and the local control console shall have the following function and information:
  - Load cell tension reading, including overload alarm;
  - Winch speed, including overspeed alarm;
  - Payout length in a digital and analog display;
  - Winch operating/running hours;
  - Pressure readings, including high and low pressure alarm;
  - Temperature readings, including hydraulic oil tank high temperature alarm;
  - Speed selector, if necessary;
  - Electronic joystick;
  - Emergency shutdown button.
- The overload alarm shall consider the tension, speed, payout length and pressure as established at load chart.
- Whenever a preset high pressure or preset low pressure is measured, the winch system shall be capable of stopping automatically the flow by closing a shutdown valve, turning off pumps and starting a deviation flow. It is necessary to avoid any type of spillage during pull-in and pull-out operations.
- The local control console shall provide safety interlocks for overload, overspeed, pressure and temperature. It shall unable the equipment start-up in case of failure of one or more system drive. It shall detect components, such as gearboxes, hydraulic motors and brakes, failure.

- Interlocks shall be inserted at Programmable Logic Controller (PLC).
- The emergency shutdown signal is required on the UNIT´s Center Control Room.

13.7 Overhead Crane

13.7.1 Overhead Crane shall be installed crossing two fix monorails, located under M09. It shall comply with the following requirements:

13.7.2 **Type:**

- Electro-hydraulic driven crane.

13.7.3 **Function:**

- Onboard and offboard operation.
- Cargo handling and equipment positioning.
- Handling and positioning of marine materials, riser and piping accessories, as transfer rigging, A&R wire rope, pull-heads, hang-off colars, closing spools, SDV interface spools, mockups and dummy spools, including assembling and disassembling of these materials at Upper Riser Balcony.
- Handling and positioning of diving station equipment, bellmouths, their components.
- Overhead crane may assist Sheave Trolley set-up, passing the pull-in wire ropes through the sheaves and passing the main wire socket through the exit turndown sheaves, as well as handle and retrieve of pull-in and pull-out riggings underwater. Overhead Crane will also lift, change positions or retrieve diving equipment during mobilization and pull-in operations.

13.7.4 **Design Requirements:**

- Overhead Crane, with its retractable arm and hook, must pass over the Sheave Trolley and have an ultralow headroom hoist configuration.
- Portside monorail beam, signaled at Figure 10, shall be replaced to allow Overhead Crane retractable arm surpasses vessel side and reach the sea level.
- SUPPLIER shall foresee at least one hatch under M09 floor to allow Overhead Crane maintenance.
- To easier maintenance access, Overhead Crane guardrail shall be dismountable.
- Overhead Crane will pass through hazardous areas and it shall have non-sparking construction and materials according to the classification of their respective locations.

13.7.5 **Performance Requirements:**

- Rated capacity, SWL: 99kN (10tf) at any position.
- Retractable arm reach: 3.5m from balcony border as shown at Figure 10.
- During offboard operation, the hoist shall be lowered for 40m or more, until water level.
- Overhead Crane capacity shall allow operation continuity, regardless the position or reach of retractable arm, for example.
- The reach shall be confirmed during detailed design by SUPPLIER and informed to PACKAGER/MANUFACTURER.
- The full load test shall 25% beyond the rated capacity, SWL.
- Maximum capacity, stall: 123kN (12.5tf).
- Minimum static brake capacity: 148kN (15tf).
- Parking/emergency brake capacity: 148kN (15tf).
- The brake capacity shall be 1.5 times the rated capacity, SWL.
- Rated speed: 5m/min for hoisting;
  1.5m/min for crane displacement along monorails;
  1.0m/min for retractable arm displacement;
  1.0m/min for trolley displacement along retractable arm.

13.7.6 **Functional Requirements:**

- Monorails, crane and hook shall be yellow painted.
- They shall be clearly marked with its unique tag number and its safe working load.
- Monorails shall be supported by structural beams and equipped with bolted end stops which allow installing and removing the crane from beams.
- Monorails beams maximum span, section, dimensions, alignment tolerance and flatness shall be considered during detailed design by SUPPLIER and PACKAGER/MANUFACTURER.

- Trolleys running on beams transversely installed, with respect to the vessel axis, shall be fitted with locking devices or positive traction (rack and pinion or sprocket wheel and geared rack), to ensure safe handling conditions under the FPSO lateral motions and accelerations.
- The retractable arm shall be located above the object to be lifted.
- Fleet angle shall be informed by PACKAGER/MANUFACTURER.
- It shall have stable and safe support in any position with an anti-slip system.
- The trolley shall have parking brakes to secure the correct positioning and to prevent any unintended motion of the trolley.
- It shall have trust and precise lowering control for delicate operations.
- It shall be moved front and back, up and down via electronic joystick control.
- The hydraulic skidding gripper/claw shall operate in both rails.
- PACKAGER/MANUFACTURER shall define the hydraulic skidding speed.
- Electrical power shall be supplied to the trolley through a cable drag chain system or similar.
- It shall have an efficient electric cable guide system for preventing cable kink.
- Grating floor shall be according to I-DE-3010.00-1400-140-P4X-004 - GENERAL NOTES FOR TOPSIDES STRUCTURES.
- PACKAGER/MANUFACTURER shall foresee access to allow crane maintenance.
- To easier maintenance access, crane guardrail shall be dismountable and complying with I-DE-3010.00-1400-140-P4X-003 - STANDARD-STEEL GUARDRAIL - TYPICAL DETAILS and I-DE-3010.00-1400-140-P4X-011 - STANDARD-PULTRUDED GUARDRAIL - TYPICAL DETAILS.
- All crane components as lights, cameras and horns shall be installed avoiding dropping risks with an efficient secondary anchorage system using stainless steel wire ropes and nets.

13.7.7 **Drum and Wire Rope Requirements:**

- The drum shall be LEBUS type in order to store one wire rope.
- Minimum drum diameter shall be 20 times the wire rope nominal diameter.
- The wire rope shall be galvanized, low rotation, right hand Lang's, full plastic coating of IWRC, compacted strands, abrasion resistant and resistant to drum crushing, 1960 N/mm^2 grade, with closed spelter socket at working end, heavy duty lubrication, crushing and bending fatigue resistant, or equivalent and MBL 314kN (32tf = 2.5x maximum pulling capacity).
- The wire rope length shall be 100m. This length does not include any dead turn.
- PACKAGER/MANUFACTURER shall define total length with a minimum of three dead turns on the drum.
- The anchorage of the wire rope to the drum including dead turns shall have strength not less than 80% of the MBL´s wire rope.
- The wire rope shall be furnished with closed spelter socket CROSBY type or similar.
- The crane shall have an efficient rope guide system for preventing the rope overlapping in the winding.
- The crane shall be delivered at site with wire rope already spooled and pre-tensioned for hoisting operation.

13.7.8 **Crane Braking Requirements:**

- The crane drum shall be capable of being braked at all load levels.
- The brake shall be automatically released by pressure from the HPU at hoisting or lowering, i.e. at normal operation.
- The brake shall automatically engage when hoisting or lowering has stopped, i.e. speed control in neutral position.
- The crane shall be automatically braked in events of hydraulic power failure.
- The crane system shall have additional release stand-alone system by stored energy, which will enable the brake to be released in a controller manner in events of hydraulic power failure.
- It is required fail-safe automatic brakes and emergency lowering.

13.7.9 **Crane Monitoring Requirements:**

- The crane shall be provided with independent monitoring system and crane control system.
- The crane monitoring system and the local control console shall have the following function and information:
  - Load cell tension reading, including overload alarm;
  - Payout length in a digital and analog display;

- Crane operating/running hours;
- Temperature readings, including hydraulic oil tank high temperature alarm;
- Electronic pendant pushbutton;
- Emergency shutdown button.

- The local control console shall provide safety interlocks for overload, overspeed, pressure and temperature.
- Interlocks shall be inserted at Programmable Logic Controller (PLC).
- It shall provide constant tension function.
- The crane shall be moved front and back, up and down via electronic pendant pushbutton.
- The emergency shutdown signal is required on the UNIT´s Center Control Room.

13.8 Hydraulic Power Unit (HPU)

13.8.1 **Functional Requirements:**

- The HPU shall be installed on Riser Pull-in Structure (RPS), close to the Main Winch.
- The same HPU will power the Main and Auxiliary Service Winches as established at I-DE-3010.2Q-5139-944-P4X-002 - PIPING AND INSTRUMENT DIAGRAM HYDRAULIC SYSTEM FOR RISER PULL-IN SYSTEM.
- SUPPLIER shall confirm if all services can operate properly, including Sheave Trolley and Overhead Crane hydraulic skidding and locking, using the main HPU or if it is necessary to install an additional HPU for these services.
- In case an additional HPU is necessary for Sheave Trolley or Overhead Crane, it shall be air cooled, as cooling water will not be available for the equipment. If the installation on the Sheave Trolley isn't possible, the HPU shall be installed in the Riser Pull-in Structure (RPS) and a drag chain must be installed for guiding the hydraulic flexible hoses to the moving trolley distribution box.
- The total number of HPUs shall be optimized according to design possibilities. The final solution shall be SUPPLIER scope of work and it shall be approved by OWNER.
- The HPU capacity shall be confirmed at detailed design by PACKAGER/MANUFACTURER. The criteria for hydraulic system sizing and associated calculations shall be demonstrated and provided to OWNER. The hydraulic system shall be design allowing main and both service winches simultaneous operation.
- The winches speeds in simultaneous operation shall be minimum of 2m/min (top layer). PACKAGER/MANUFACTURER shall evaluate the electrical configuration necessary for HPU sizing, including quantity and rated power of motors and the number of spares, if applicable.
- The HPU shall be suitable for operating in a saline atmosphere with suitable marine treatment and have a skid base to permit supporting strength, transportation and installation of the unit.
- The HPU shall be completely self-contained, fresh water-cooled electro-hydraulic power unit. The HPU must be equipped with at least 2 (two) electric motors, driving independent hydraulic pumps to provide redundancy. Valving shall allow no-load motor starting.
- The HPU shall mounted with all valves, piping, tubing, hoses, flanges, gauges, fittings, sensors, reservoir, cooler, filters, suction strainers, pumps, heaters, distribution manifold, electric motors, junction boxes, wiring and all other components necessary to allow operation without additional components, except for hydraulic oil.
- Piping, tubing and hose fittings shall be on stainless steel ASTM A 269 Gr. TP 316.
- Hoses shall be provided with quick-connect and disconnect couplings with threaded connection and check valves on both extremities. Hoses within HPUs shall be minimized.
- All piping, tubing and hoses within HPUs shall be properly routed and supported. It shall be installed drip pans at HPU and connections with Main and Auxiliary Service Winches and Sheave Trolley. Cables and wires shall be routed on cable trays and fastened with stainless steel bands.
- Hydraulic oil tank shall be on stainless steel AISI 316 with adequate interior baffles.
- Hydraulic oil tank shall be provided with manholes for inspection access and a point to collect sample oil.
- Oil filling shall be arranged through the return filter and tank shall be supplied full of hydraulic oil.
- A list of compatible hydraulic oil from different international suppliers shall also be stated in the technical proposal for OWNER approval.
- All internal component parts shall be compatible with the adopted hydraulic fluid, in order to avoid any degradation.

- There shall be a sight gauge on the tank for oil level and temperature.
- In case one electric motor/hydraulic pump fails, the HPU shall be able to power the winch at reduced speeds, but at full design loads. Manual control valves shall be provided at the HPU to isolate any pump from the remainder of the pumps. Pumps and motors shall be interchangeable.
- An emergency shutdown button for each HPU shall be located in the control console, independently of other control functions.
- All analog signal cables inside HPU shall be shielded to prevent electromagnetic interference caused by electrical motors. Electrostatic shields are not to be earthed, but to be connected to junction box terminals.
- The HPU will be supplied by 1 (one) 690V, 60Hz, 3Ph.
- The HPU shall be single point grounded and the panels shall be stand-alone type, fitted with pad-eyes for hoisting.
- PACKAGER/MANUFACTURER shall provide design, furnishing, assembly of cabling, cable trays, cable glands and all other activities/materials associated to the HPU supply.