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|  | TECHNICAL SPECIFICATION | | Nr: I-ET-3010.2E-5139-390-P4X-004 |
| | CLIENT: SRGE | | SHEET: 1 of 34 |
| | JOB : REFERENCE HULL 01 | | |
| | AREA: - | | |
| SRGE | TITLE: MOORING SYSTEM | | INTERNAL |
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INDEX OF REVISIONS

| R E V . | DESCRIPTION AND/OR REVISED SHEETS |
|---------|-----------------------------------|
| 0 | ORIGINAL ISSUE |
| A | REVISED WHERE INDICATED |


| | REV. 0 | REV. A | REV. B | REV. C | REV. D | REV. E | REV. F | REV. G | REV. H |
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| CHECK | CMRR | CMRR | | | | | | | |
| APPROVAL | CXZ0 | CXZ0 | | | | | | | |


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THIS FORM IS PART OF PETROBRAS N-381 REV.J ANNEX A – FIGURE A.1.

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1. INTRODUCTION

1.1. OBJECTIVE

The purpose of this technical specification is to describe the minimum requirements for the design, manufacturing, assembly, supply, installation, commissioning and tests of MOORING SYSTEM in conformance with relevant regulations and High Capacity FPSO design documentation.

1.2. DEFINITIONS

PACKAGE: It is defined as an assembly of equipment supplied interconnected, tested and ready to operate, requiring only the available utilities from the Unit for the Package operation.

PACKAGER: It is defined as the responsible for project, assembly, construction, fabrication, testing and furnishing of the Package.

OWNER: PETROBRAS.

MOORING SYSTEM the package name.

All definitions are found on I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS.

1.3. ABBREVIATIONS


| | |
|---------|---|
| CCR | Central Control Room |
| CS | Classification Society |
| FAT | Factory Acceptance Tests |
| FPSO | Floating Production Storage and Offloading Unit |
| HPU | Hydraulic Power Unit |
| NDT | Non-Destructive Tests |
| SOS | Supervisory and Operation System |
| SOS-HMI | Human Machine Interface of SOS |

2. NORMATIVE REFERENCES

2.1. INTERNATIONAL CODES, RECOMMENDED PRACTICES AND STANDARDS

PACKAGE equipment shall be designed and manufactured in accordance with the following codes and standards, if not mentioned otherwise.

- ANSI American National Standards Institute

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- ASME American Society Of Mechanical Engineers
- EN European Standards
- IMO – International Maritime Organization
- ISO International Standard Organization
- VDE / IEC German National Electric Standard Codes / International Electric Codes
- Classification Society defined for the Hull scope.
- IMO MODU Code, 2009
- IACS W22 - Offshore Mooring Chain
- Bureau Veritas, NI604 - Fatigue of top chain of mooring lines due to in-plane and out-of-plane bendings
- ISO 1704 - Ships and marine technology — Stud-link anchor chains

2.2. BRAZILIAN CODES AND STANDARDS

- NR – Brazilian Federal Government Regulatory Norms (Normas Regulamentadoras NRs)
- NORMAM-01 – Normas da Autoridade Marítima para Embarcações Empregadas na Navegação em Mar Aberto;


2.3. CLASS APPROVAL AND CERTIFICATION

PACKAGE shall be designed, manufactured and tested according to the design reference documents, normative requirements and in accordance with the latest editions of Classification Society Rules, Regulations and Standards.

3. REFERENCE DOCUMENTS

3.1. REFERENCE HULL 01 FPSO DESIGN

| REF DOC NUMBER | REF DOC NAME |
|-------------------------------|--|
| HULL SYSTEMS | |
| I-DE-3010.2E-5139-944-P4X-004 | MOORING HYDRAULIC SYSTEM |
| I-MD-3010.2E-1200-940-P4X-027 | DESCRIPTIVE MEMORANDUM - HULL SYSTEMS |
| I-DE-3010.2E-5120-944-P4X-001 | ENGINE ROOM CENTRAL FRESH WATER COOLING SYSTEM |


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| I-FD-3010.2E-5120-456-P4X-001 | ENGINE ROOM CENTRAL FRESH WATER COOLER (P-5120501A/B) |
| PIPING | |
| I-ET-3010.2E-1200-200-P4X-001 | PIPING SPECIFICATION FOR HULL |
| I-ET-3010.2E-1200-200-P4X-004 | REQUIREMENTS FOR PIPING SUPPORTS |
| NAVAL | |
| I-DE-3010.2E-1350-960-P4X-002 | CAPACITIES PLAN |
| I-DE-3010.2E-1350-964-P4X-001 | TOWING ARRANGEMENT |
| CONSTRUCTION | |
| I-DE-3010.2E-1357-140-P4X-001 | MOORING BALCONIES AND FAIRLEADS STRUCTURE (AFT) |
| I-DE-3010.2E-1357-140-P4X-002 | MOORING BALCONIES AND FAIRLEADS STRUCTURE (FWD) |
| HULL STRUCTURE | |
| I-DE-3010.2E-1351-140-P4X-001 | HULL GENERAL NOTES AND TYPICAL DETAILS |

3.2. TYPICAL DOCUMENTS

| REF DOC NUMBER | REF DOC NAME |
|-------------------------------|---|
| GENERAL | |
| 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 |
| CONSTRUCTION | |
| I-ET-3010.00-1200-955-P4X-001 | WELDING |
| I-ET-3010.00-1000-970-P4X-002 | REQUIREMENTS FOR NDT |


| | |
|-------------------------------|---|
| I-ET-3010.00-1200-955-P4X-002 | REQUIREMENTS FOR WELDING INSPECTION |
| I-ET-3010.00-0000-970-P4X-001 | REQUIREMENTS FOR PROCEDURES AND PERSONNEL QUALIFICATION AND CERTIFICATION |
| I-ET-3010.00-1200-940-P4X-002 | GENERAL TECHNICAL TERMS |
| MECHANICAL | |
| I-ET-3010.00-1200-300-P4X-001 | NOISE AND VIBRATION CONTROL REQUIREMENTS |
| I-ET-3010.00-1200-451-P4X-001 | REQUIREMENTS FOR SHELL AND TUBE HEAT EXCHANGER DESIGN AND FABRICATION |
| I-ET-3010.00-1200-456-P4X-001 | REQUIREMENTS FOR PLATE HEAT EXCHANGER DESIGN AND FABRICATION |
| I-ET-3010.00-1352-130-P4X-001 | FLOOR GRATINGS, TRAY SYSTEMS AND GUARDRAILS MADE OF COMPOSITE MATERIALS |
| PAINTING | |
| I-ET-3010.00-1200-956-P4X-002 | GENERAL PAINTING |
| DR-ENGP-I-1.15 | COLOR CODING |
| SAFETY | |
| I-ET-3010.00-5400-947-P4X-002 | SAFETY SIGNALING |
| DR-ENGP-M-I-1.3 | SAFETY ENGINEERING GUIDELINE |
| PIPING | |
| I-ET-3010.00-1200-251-P4X-001 | REQUIREMENTS FOR BOLTING MATERIALS |
| ELECTRICAL | |
| I-DE-3010.00-5140-700-P4X-003 | GROUNDING INSTALLATION TYPICAL DETAILS. |

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| 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 AND EQUIPMENT FOR OFFSHORE UNITS |
| I-ET-3010.00-5140-700-P4X-003 | ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS |
| I-ET-3010.00-5140-712-P4X-001 | LOW-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS |
| I-ET-3010.00-5140-712-P4X-002 | MEDIUM-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS |
| INSTRUMENTATION AND AUTOMATION | |
| I-ET-3010.00-1200-800-P4X-002 | AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS |
| I-ET-3010.00-1200-800-P4X-013 | GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS |
| I-ET-3010.00-5500-854-P4X-001 | MACHINERY MONITORING SYSTEM |
| I-ET-3010.00-5520-888-P4X-001 | AUTOMATION PANELS |
| I-ET-3010.00-1200-800-P4X-015 | REQUIREMENTS FOR TUBING AND FITTING (ALIGNED TO IOGP-JIP33 S-716) |
| NAVAL | |
| I-ET-3010.00-1350-960-P4X-001 | DESIGN REQUIREMENTS – NAVAL ARCHITECTURE |

3.3. SPECIFIC PROJECT DOCUMENTS

| REF DOC NUMBER | REF DOC NAME |
|---------------------------|---------------------|
| GENERAL | |
| I-DE- GENERAL ARRANGEMENT | GENERAL ARRANGEMENT |

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| I-DE- AREA CLASSIFICATION – GENERAL | AREA CLASSIFICATION – GENERAL |
| I-ET- AUTOMATION INTERFACE OF PACKAGE UNITS | AUTOMATION INTERFACE OF PACKAGE UNITS |
| I-ET- METOCEAN DATA | METOCEAN DATA |
| I-RL- GENERAL SPECIFICATION FOR AVAILABLE UTILITIES | GENERAL SPECIFICATION FOR AVAILABLE UTILITIES |
| I-RL- MOTION ANALYSIS | MOTION ANALYSIS |
| NAVAL | |
| I-FD-MOORING LINES TOP CHAIN SPECIFICATION AND PRE-TENSION | MOORING LINES TOP CHAIN SPECIFICATION AND PRE-TENSION |
| I-DE- MOORING LINES ARRANGEMENT | MOORING LINES ARRANGEMENT |
| COMMISSIONING | |
| I-MD- COMMISSIONING DESCRIPTIVE MEMORANDUM | COMMISSIONING DESCRIPTIVE MEMORANDUM |
| MECHANICAL | |
| I-ET- MATERIAL SPECIFICATION FOR HEAT EXCHANGERS | MATERIAL SPECIFICATION FOR HEAT EXCHANGERS |

Table 1 – Reference Documents


Note: these documents title and number may vary slightly from one project to another. project's document list shall be consulted in order to verify the correct document number and title.

4. DESIGN REQUIREMENTS

4.1. DESIGN CONDITIONS

4.1.1. PACKAGE Equipment shall be designed for a 30-year life in a corrosive offshore environment without the need for replacement of any major component due to wear, corrosion, fatigue, or material failure.

4.1.2. PACKAGER shall design the equipment for the full range of operational conditions as specified in this technical specification.

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| <p>4.1.3. PACKAGE Equipment shall be designed with the compliance of the normative and design requirements as stated in this specification and complying with the technical parameters stated on the above item 3 with the REFERENCE HULL 01 FPSO basic design reference documents.</p> <p>4.2. SAFETY REQUIREMENTS</p> <p>4.2.1. Personnel safety protection shall be provided according to Brazilian Regulatory Norms (NR) issued by Brazilian Government.</p> <p>4.2.2. Warning signs in Brazilian Portuguese language shall be provided where risk of personnel injury exist.</p> <p>4.2.3. Rotating equipment outer parts, such as pulleys, couplings, belts and flywheels, shall have rigid protection, manufactured with aluminum ASTM B211 and shall be capable of being easily removed.</p> <p>4.2.4. In accordance with the requirements of SOLAS II-1, Regulation 3-5, and MSC.1/Circ. 1379, all equipment and material to be supplied by PACKAGER must be “asbestos free”.</p> <p>4.2.5. Safety signaling shall be in full compliance with I-ET-3010.00-5400-947-P4X-002 – SAFETY SIGNALING.</p> <p>4.2.6. For additional safety requirements refer to DR-ENGP-M-I-1.3 – SAFETY ENGINEERING GUIDELINE.</p> <p>4.3. NOISE AND VIBRATIONS</p> <p>4.3.1. Noise and vibrations limits shall be in conformance with I-ET-3010.00-1200-300-P4X-001 – NOISE AND VIBRATION CONTROL REQUIREMENTS.</p> <p>4.4. MOTIONS AND ACCELERATION</p> <p>4.4.1. All equipment shall be able to withstand with the UNIT subjected to 100-year return period environmental conditions.</p> <p>4.4.2. All equipment shall be able to operate with the UNIT subjected to 1-year return period environmental conditions.</p> <p>4.4.3. All environmental conditions are defined in I-ET-METOCEAN DATA, at any draft from fully loaded to the minimum loaded / ballasted condition.</p> <p>4.4.4. For the Hull loading conditions details and the maximum designed operational trim and heel inclinations refer to I-ET-3010.00-1350-960-P4X-001 – DESIGN REQUIREMENTS – NAVAL ARCHITECTURE.</p> <p>4.4.5. For the design data and information regarding motion requirements refer to I-RL-MOTION ANALYSIS.</p> <p>4.4.6. PACKAGE is also to withstand inertial forces during transportation from</p> | | | |


construction site to the final offshore location.

5. PACKAGE SPECIFICATION AND TECHNICAL REQUIREMENTS

5.1. SCOPE OF SUPPLY:

5.1.1. Mooring System components and accessories are listed on *Table 2*. A schematic drawing (illustrative only) is presented in *Figure 1*.

| Equipment | item # in Figure 1 | TAG | Quantity |
|--|-----------------------------|-------------------|----------|
| Chain Jack | 1 | Z-Z-5139501A/D-01 | 4 |
| Moorig Fairlead (FWD Portside) | 3 | Z-1357501A/G | 7 |
| Moorig Fairlead (AFT Portside) | 3 | Z-1357502A/G | 7 |
| Moorig Fairlead (AFT Starboard) | 3 | Z-1357503A/G | 7 |
| Moorig Fairlead (FWD Starboard) | 3 | Z-1357504A/G | 7 |
| Motorized Turndown Sheave | 9 | Z-Z-5139501A/D-02 | 4 |
| Chain Locker | 8 | - | 4 |
| Chain Stopper FWD Portside | 2 | Z-5139505A/G | 7 |
| Chain Stopper FWD Starboard | | Z-5139504A/G | 7 |
| Chain Stopper AFT Portside | | Z-5139502A/G | 7 |
| Chain Stopper AFT Starboard | | Z-5139503A/G | 7 |
| Chain Stopper FWD Portside Control Panel | - | PN-Z-5139505A/G | 1 |
| Chain Stopper FWD Starboard Control Panel | - | PN-Z-5139504A/G | 1 |
| Chain Stopper AFT Portside Control Panel | - | PN-Z-5139502A/G | 1 |

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| Chain Stopper AFT Starboard Control Panel | - | PN-Z-5139503A/G | 1 |
| Hydraulic Power Unit for Mooring system (FWD) | - | UH-5139505B | 1 |
| Hydraulic Power Unit for Mooring system (AFT) | - | UH-5139505A | 1 |
| Hydraulic Power Unit for Mooring system (AFT/FWD) Control Panel | - | PN-UH-5139505A | 1 |
| Hydraulic Power Unit for Mooring system (AFT/FWD) Control Panel | - | PN-UH-5139505B | 1 |
| Tugger (Auxiliary) Winch | 10 | GN-Z-5139501A/D | 4 |
| Skidding System – Gantry Brake | - | GC-Z-5139501A/D | 4 |
| Drip Pan | 7 | - | 4 |
| Lighting | 12 | - | Note (1) |
| Drag Chains ⁽²⁾ | - | - | 4 |
| Local Controls | - | - | 4 |
| Installation Chain | 14 | - | 4 |
| Support Chain | 15 | - | 28 |
| Messenger Wire Rope | 16 | - | 28 |
| LLLC Link | 17 | - | 6 |
| Connecting Shackle | 21 | - | 84 |
| Tail Chain | 22 | - | 28 |
| HMPE Cable | 23 | - | 28 |
| Heaving Line | - | - | 28 |

Table 2 – Scope of Supply – Mooring Equipment and Accessories

Notes:

(1) For lighting details see item 6.11.1.

(2) Drag Chains for guiding the hydraulic flexible hoses that connect hydraulic headers tie-in points to the movable parts of Mooring System.

(3) The MOORING SYSTEM and related accessories shall be designed to receive up to 7 mooring lines per bundle.

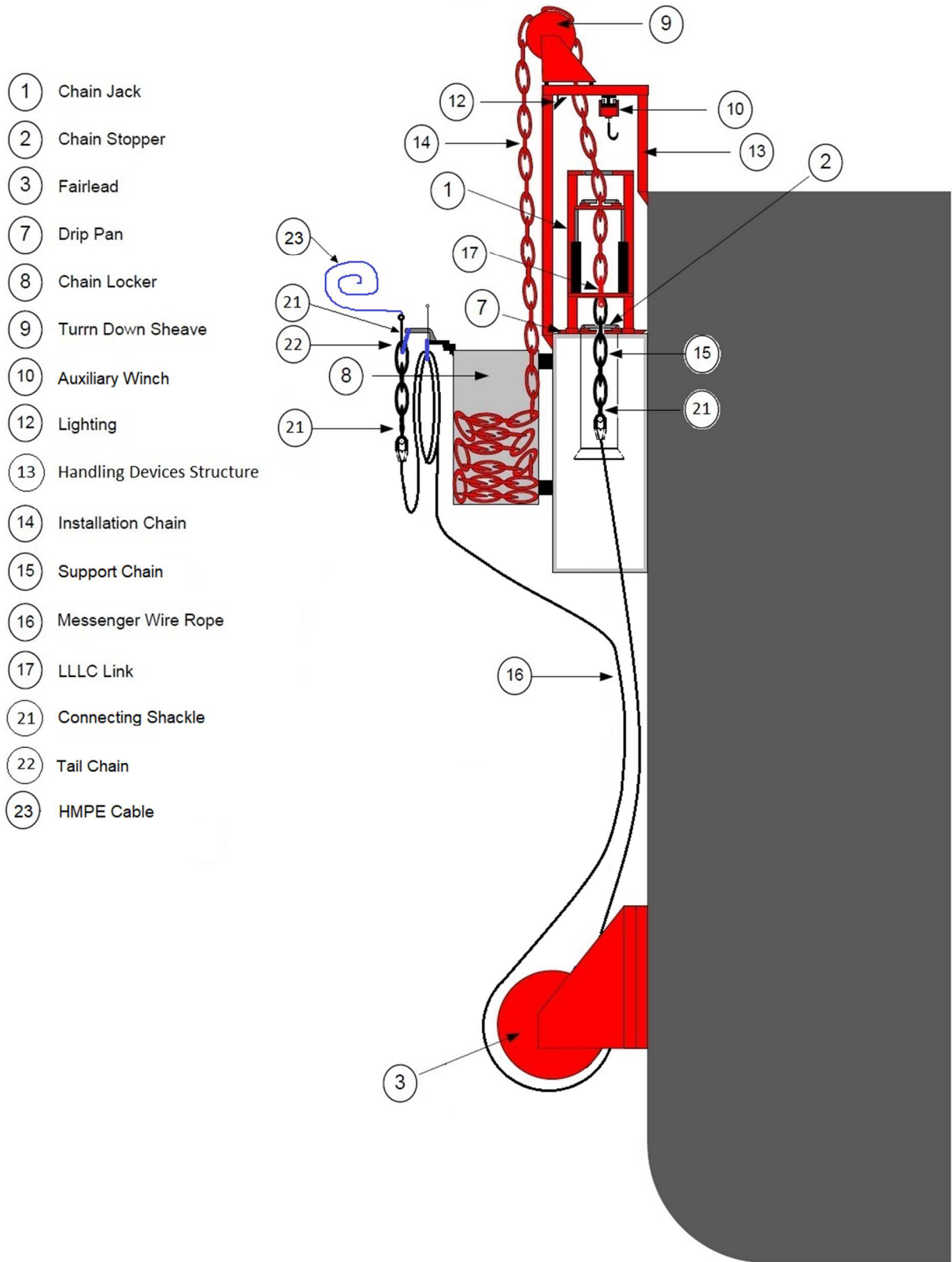


Figure 1 – Schematic arrangement of mooring system and components to be supplied

5.1.2. It is also included in this PACKAGE four (4) Towing Retrieval Winches listed on *Table 3* below.

| Equipment | TAG | Quantity |
|------------------------------|---------------|----------|
| Towing Retrieval Winch (AFT) | GN-1350501A/B | 2 x 100% |
| Towing Retrieval Winch (FWD) | GN-1350502A/B | 2 x 100% |

Table 3 – Scope of Supply –Towing Retrieval Winches

- o Note: Document I-DE-3010.2E-1350-964-P4X-001 – TOWING ARRANGEMENT shall be consulted for other towing equipment and accessories that shall be supplied by HULL SUPPLIER but that are not included in this Technical Specification.

5.1.3. The PACKAGE scope shall include all required main, secondary and auxiliary mechanical hardware (hydraulic jacks, winches, deviation sheaves, fairleads, blocks, rollers, pad eyes, wire ropes, etc.), spare parts and all equipment to allow all necessary operations of the MOORING SYSTEM.

5.1.4. All other parts or components required for the safe and full operation of the system.

5.2. EQUIPMENT LOCATION

5.2.1. MOORING SYSTEM will be installed in the FPSO side shell, near main deck elevation, 2 (two) at the forward (PS/SB) and 2 (two) at the stern (PS/SB). Document I-DE-GENERAL ARRANGEMENT shall be consulted for more details.

5.2.2. Hydraulic power unit for mooring system, Fwd/Aft, shall be installed at the Fore castle/Engine room, respectively.

5.2.3. MOORING SYSTEM hazardous area requirements shall comply with I-DE- AREA CLASSIFICATION – GENERAL.

6. TECHNICAL SPECIFICATION


6.1. GENERAL


6.1.1. The mooring lines pattern and FPSO Heading are shown on I-DE-MOORING LINES ARRANGEMENT.


6.1.2. The specific project data sheet I-FD-MOORING LINES TOP CHAIN SPECIFICATION AND PRE-TENSION shall be consulted for the following information:

- Mooring lines top chain segment specification (diameter, MBL, etc).
- Highest mooring line pre-tension at fairlead.

6.1.3. All components of MOORING SYSTEM, including (but not limited to) fairlead,

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| <p>chain-jack, chain stopper, turn down sheave and chain locker, shall be suitable to operate with the mooring line top chain segment, as well as with the LLLC link to be used to connect top chain with installation chain, or support chain with installation chain.</p> <p>6.1.4. LLLC link is described on item 6.19 of this specification.</p> <p>6.1.5. The MOORING SYSTEM design shall take in consideration possible variation on mooring chain dimensions, according to standard IACS W22 and ISO 1704 acceptable tolerances.</p> <p>6.1.6. The MOORING SYSTEM shall be designed to perform the following operations:</p> <ul style="list-style-type: none"> • Mooring lines hook-up, including but not limited to the tasks below: <ul style="list-style-type: none"> - to unlock the fairleaders (see item 6.3.8); - to transfer the messenger wire rope from FPSO to AHTS vessel; - To pay-out installation chain from chain locker to AHTS vessel; - To recover the installation chain and mooring line top segment from AHTS vessel; - To lock mooring line top segment on respective chain stopper. • Mooring lines final tensioning; • To discard the top chain excess from FPSO to AHTS vessel (these chains shall not remain in the chain locker after final tensioning operation); • To pull-out the entire installation chain from chain locker to AHTS vessel and pull-in a new one; • De-installation of the mooring lines. <p>6.2. MOORING EQUIPMENT ARRANGEMENT AND DESCRIPTION</p> <p>6.2.1. The mooring lines will be disposed in four bundles (starboard-bow, starboard-aft, portside-aft, portside-bow). There will be one mooring balcony for each bundle assembled on hull side shell, near Main Deck elevation. The balconies shall be designed to receive up to 7 mooring lines each.</p> <p>6.2.2. Each mooring line shall enter the FPSO through a fairlead and be supported by a chain stopper installed on the balcony deck.</p> <p>6.2.3. One (1) movable chain jack with its own turn-down sheave on top (named as chain jack assembly) shall be supplied for each mooring balcony (a total of 4 chain jacks for the FPSO). The MOORING SYSTEM shall have permanent means to move the chain jack assembly through the balcony so that it can be positioned over each chain stopper of that bundle, to pay out or retrieve the Installation Chain or top chain, as required. The balconies and mooring equipment shall be designed so that there are no interferences with other structures in the FPSO.</p> <p>6.2.4. MOORING SYSTEM shall be equipped with drag chains, that are devices for</p> | | | |

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| <p>guiding and organizing the hydraulic flexible hoses connected to the movable part, while it dislocates. The drag chains shall be designed to reduce wear and stress on hoses, prevent entanglement, improve operator safety and efficiency during operation. It shall be possible to move the chain jack assembly to any mooring line of that bundle, without human intervention to distribute or accommodate the hydraulic flexible hoses.</p> <p>6.2.5. It shall be provided at least one (1) chain locker (fixed or movable) per mooring bundle.</p> <p>6.2.6. The movable structure of the MOORING SYSTEM shall properly dislocate along the balcony and park, even when the chain locker is full of chain (in case of movable chain locker).</p> <p>6.2.7. MOORING SYSTEM shall have means to fully discard all mooring lines stored in chain locker to an anchor handling tug supply vessel (AHTS) and to pull-in a new installation chain from AHTS to chain locker. There shall be a discard hole at the deck of each mooring balcony (additional to the slots that will be occupied by each mooring line), properly designed for such operations.</p> <p>6.2.8. The fairleads, chain stoppers and chain jack assemblies shall be arranged in a way to avoid unnecessary wear on the chain links.</p> <p>6.2.9. MOORING SYSTEM shall be provided with portable control panels on each balcony allowing to operate the system in front (and near) each chain stopper and on the platform above the chain jack assembly. For more details on see item 6.8.</p> <p>6.2.10. Auxiliary handling devices shall be provided for each bundle to assist on mooring operations, as detailed on item 6.10.</p> <p>6.3. FAIRLEAD</p> <p>6.3.1. The MOORING SYSTEM shall have fairleads compatible with top chain segments of each mooring line, to be installed on FPSO hull side-shell.</p> <p>6.3.2. The fairleads and incoming mooring lines shall not constitute navigation hazards to other vessels.</p> <p>6.3.3. The fairleads shall be eccentric type (azimuthal sheaves) and self lubricated with docking points adapted for removal and/or installation.</p> <p>6.3.4. The fairleads shall be suitable to operate with the chosen chain jack assembly arrangement and should not submit the chain links to severe bending or shear. In-plane and out-of-plane bending of the chains shall be demonstrated to be as low as possible. BV NI604 offers a guideline for such assessment. Other rules and guidelines may be adopted upon OWNER approval.</p> <p>6.3.5. PACKAGER shall supply information documenting that the links will fit properly in the fairlead pockets without distortion, damage or excessive stresses which may initiate cracks or failures leading to reduced chain MBL (minimum breaking load)</p> | | | |

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or design life.


- 6.3.6. Detailed stress calculations and fatigue calculations shall be carried out on fairleads in accordance with the CS rules.
- 6.3.7. The mooring chain handling between the chain stopper and the fairlead must occur without obstruction, with enough room to allow free passage of the mooring chain, both for retrieve and pay-out operations (with or without tension in the chain).
- 6.3.8. For the FPSO towing to site location, the fairleads shall be accommodated flipped backwards in relation to towing direction to minimize loads and stress due to wave passage. Such fairlead stowage arrangement shall allow to initiate the hook-up operation by any mooring line of the bundle (one fairlead shouldn't obstruct the operation of another), considering azimuth angles defined by I-DE- – MOORING LINES ARRANGEMENT. The fairlead locking mechanism shall be easily removable, on hook-up operation, from mooring balcony deck, without the need of climbers. Other procedures may be proposed subject to OWNER's approval.
- 6.3.9. The fairlead supporting structure shall minimize effects of slamming due to passage of waves.
- 6.3.10. Fairlead maximum operational azimuth angle shall be compatible with mooring lines pattern given by I-DE-MOORING LINES ARRANGEMENT.

6.4. CHAIN STOPPER

- 6.4.1. Hydraulically operated flapper-type chain stoppers shall be installed on mooring balcony, one per mooring line, on top of the hawse pipes.
- 6.4.2. The chain stopper shall have a load bearing capacity equal to 120% of the mooring line's top chain segment MBL (minimum breaking load).

Note: Mooring line top chain specification is defined in I-FD-MOORING LINES TOP CHAIN SPECIFICATION AND PRE-TENSION.

- 6.4.3. The chain stopper shall be designed to support the chain in a manner to minimize chain wear.
- 6.4.4. The chain stopper shall be designed to allow the LLLC chain link to pass through.
- 6.4.5. PACKAGER shall supply information documenting that the links will fit properly in the chain stopper without distortion, damage or excessive stresses which may initiate cracks or failures leading to reduced MBL or design life.
- 6.4.6. Below each chain stopper there should be a cross-section opening, with dimensions compatible with top chain segment, to prevent torsion on the mooring line. Such structure shall not obstruct suitable passage of mooring line both on recovery and pay-out operations.
- 6.4.7. Detailed stress calculations and fatigue calculations shall be carried out on

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exposed chain stopper parts and chain link.

6.4.8. Any kind of technical failure or operational failures shall under no circumstances lead to uncontrolled chain pay-out.

6.5. CHAIN TENSION MONITORING SYSTEM

6.5.1. Each chain stopper shall be provided with a chain tension monitoring system. The chain tension signals shall be connected to Central Control Room (CCR) supervisory system and shall be available in the balcony's local control.

6.5.2. The tension measurement shall be made by compression load-cells or load-pins. Instrumented chain stopper paws (with strain gauges integrated on its body) are not accepted.

6.5.3. The load-cells or load-pins shall have backup gauges so that, in case of failure of the main circuit, it is possible to change the readings to the second circuit.

6.5.4. The load-cells or load-pins shall be designed, as a minimum, for the same load bearing capacity (and same safety factor) than the chain stopper.

6.5.5. Each load-cells or load-pins shall be calibrated by its manufacturer against a recognized standard and the calibration curves shall be informed on Mooring System documentation.

6.5.6. Accuracy of the chain tension monitoring system shall be within 5% in the range between 50% and 200% of the highest mooring line pre-tension. Outside this range larger tolerances can be accepted but should be discussed with OWNER.


6.5.7. Load-cells/load-pins operational limit (maximum admissible load without damaging its electronics) shall be 200% F.S. (full scale).

6.5.8. Each chain stopper, assembled with respective chain tension monitoring system, shall be load tested during FAT (factory acceptance tests), to demonstrate system accuracy as defined on item 6.5.6 above. A recognized calibration standard shall be followed.

Note 1: The load-cell or load-pin individual calibration certificate, issued by its manufacturer, does not exempt above test.


6.5.9. The tension monitoring system shall have alarms in case of rupture on any mooring line.

6.5.10. Chain Stopper design shall allow the replacement of load-cells or load-pins (for recalibration or repair), with mooring lines installed with pre-tension levels. That is, without the need to reduce mooring line tension or to pay-out the mooring line to an AHTS vessel. The tools needed for that replacement shall be included in the PACKAGER scope of supply. The load cells replacement procedure, including necessary tools and equipment, shall be presented to OWNER for approval.

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6.6. CHAIN JACK ASSEMBLY

- 6.6.1. There shall be 1 (one) chain jack assembly for each mooring line bundle, in a total of 4 assemblies per FPSO.
- 6.6.2. Each vertical chain jack assembly shall consist of hydraulic jack, hydraulic chain grabbers, motorized turn-down sheave and the required foundations and components so each chain jack assembly is an individual unit, except of power supply.
- 6.6.3. The chain jack assembly shall be hydraulically operated, and auxiliary functions shall be hydraulically controlled.
- 6.6.4. The main task of the chain jack assembly is to pull the mooring chains from the fairleads to the chain locker and to perform the top tensioning of the mooring line. Also, the chain jack shall be able to pay-out mooring chain from the chain-locker to AHTS vessel.
- 6.6.5. A motorized turn-down sheave shall be located on top of the jacking mechanism, with means to safely guide the deployed chain to the deck for handling/cutting or to appropriately retrieve the chain to the locker for storage.
- 6.6.6. The turn down sheave minimum pull capacity (nominal) is 25T, with a minimum pay-out speed (at nominal pull capacity) of 5m/min. The turn down sheave shall be capable to pay out the installation chain to AHTS vessel, with chain jack flaps opened, considering 80m of chain out of the fairlead.
- 6.6.7. The mooring chain shall be guided safely in and out of the chain locker, through the turn down sheave, hydraulic jacks and chain stopper slot without the need of direct human interference.
- 6.6.8. PACKAGER shall ensure that the turn down sheaves are designed and fabricated so that the mooring chain links are not exposed to severe bending and wear and that the turn down sheaves are well functioning within the chosen chain jack arrangement.
- 6.6.9. The motorized turn-down sheave, jacking mechanism and fixed chain stopper shall operate in suitable synchronism with each other. An automatic / manual mode switch shall be provided. In automatic mode, the winch shall perform the step-by-step movement of the stoppers. In manual mode, the following controls shall be available:
- Chain Jack extend and retract.
 - Upper and lower stoppers opening independently.
 - Both stoppers open (lockable function).
- 6.6.10. The MOORING SYSTEM shall have proximity switches for chain stoppers flaps (or pawls) positioning. The system design shall consider possible variations on chain link dimensions (within acceptable tolerances as given by IACS W22

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and ISO 1704).


- 6.6.11. MOORING SYSTEM shall have protection mechanisms to prevent damage on the turn-down sheave, its shaft and motorized system caused by excessive load on the sheave. For example, synchronism error that may cause the mooring line tension to be unloaded over the turn down sheave.
- 6.6.12. The chain jack assembly structural strength is to be designed for the rated braking capacity and the stress levels shall not exceed the Classification Society requirements.
- 6.6.13. The chain jack assembly shall be designed with a cross shaped hole enabling the retrieved chain to be properly aligned from any angle of twist, when entering the stopper.
- 6.6.14. The stroke of the main cylinder rod shall have a margin of at least 50 mm in addition to the required design stroke. This aims to compensate for mooring chains or chain jack assembly dimensional variations.
- 6.6.15. Air bleed valves shall be provided to enable air bleeding and draining of the cylinders. The chain grabber latches shall be self-closing, in case of HPU failure.
- 6.6.16. In case of unexpected HPU shut down, the chain jack shall safely hold the tensioned chain.
- 6.6.17. Chain grabber latches and turn down sheave surfaces in contact with the chain shall be approximately 5% softer than the chain itself.
- 6.6.18. The chain jack assembly shall be equipped with a drip pan to collect all oil from any leakage. The drip pan shall have a sloped bottom and drain port.
- 6.6.19. Turn-down sheaves pockets shall fit the LLLC chain link.
- 6.6.20. The chain jack assembly pull speed shall be at least 1.5 m/min at maximum load. The pay-out speed shall be at least 1.5 m/min (chain without tension). Both operations shall be executed in automatic mode.
- 6.6.21. The chain jack pull capacity shall be defined according to the mooring lines pre-tension levels and considering the environmental conditions for hook-up operations, friction losses, etc. The minimum dynamic amplification factor to be considered shall be 1.75 times the highest mooring line pre-tension, with FPSO at target position (no external forces), at minimum draft.


Note: The specific project mooring lines pre-tension and minimum Chain Jack pull capacity are informed on I-FD-MOORING LINES TOP CHAIN SPECIFICATION AND PRE-TENSION.


6.7. HYDRAULIC POWER UNIT (HPU)

- 6.7.1. Two (2) Hydraulic Power Units (HPUs) shall be supplied, one of them shall feed PS/SB stern mooring lines clusters (UH-5139505A / Engine Room), and the other

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| <p>PS/SB bow clusters (UH-5139505B / Forecastle).</p> <p>6.7.2. It shall be possible to operate both HPUs independently. There should be no hydraulic communication between bow and stern units.</p> <p>6.7.3. The HPUs shall be dimensioned to supply enough power to operate one of the respective cluster chain jack assembly at full power and, simultaneously, all necessary auxiliary equipment as defined in the operational procedures. A minimum of 2 x 100% or 3 x 50% hydraulic pumps shall be provided for redundancy.</p> <p>6.7.4. The HPU electric motors tension shall be 480V.</p> <p>6.7.5. The HPUs shall be suitable for operating in a marine environment and adapted to tropical weather.</p> <p>6.7.6. The hydraulic distribution system from HPU to mooring bundles shall have appropriate double blocking valves (or other appropriate blocking mean) to allow isolating portside and starboard hydraulic systems. This shall allow to securely execute repairs in MOORING SYSTEM components of one side (for example starboard) while the system is normally operated in the other side (portside).</p> <p>6.7.7. If HPUs are located at a lower level than the mooring equipment on PS/SB balconies, the hydraulic system design shall have means to avoid the overflow of the HPU tank due to gravitational oil return from mooring equipment, hoses and piping.</p> <p>6.7.8. HPU shall have a clear indication of its maximum and minimum allowed oil level.</p> <p>6.7.9. Document I-DE-3010.2E-5139-944-P4X-004 – MOORING HYDRAULIC SYSTEM shall be revised on detailed design phase according to PACKAGER requirements and herein specifications.</p> <p>6.7.10. HPU shall be provided with alarm and automatic shutdown of in case of low level or high temperature of hydraulic oil in hydraulic tank.</p> <p>6.7.11. MOORING SYSTEM shall have means of protection against high pressure on hydraulic oil.</p> <p>6.7.12. The HPU shall be provided with fresh water heat exchangers for hydraulic oil cooling.</p> <p>6.7.12.1. Fresh water heat exchangers shall comply with following technical specifications:</p> <ul style="list-style-type: none"> • I-ET-3010.00-1200-451-P4X-001 - REQUIREMENTS FOR SHELL AND TUBE HEAT EXCHANGER DESIGN AND FABRICATION; or • I-ET-3010.00-1200-456-P4X-001 - REQUIREMENTS FOR PLATE HEAT EXCHANGER DESIGN AND FABRICATION; and I-ET- MATERIAL SPECIFICATION FOR HEAT EXCHANGERS. | | | |

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| <p>6.7.13. The HPUs heat exchangers shall have higher hydraulic oil pressure than cooling fresh water pressure in all scenarios.</p> <p>6.7.14. HPUs and its panels shall be arranged in locations with adequate space for maintenance as defined by PACKAGER.</p> <p>6.7.15. HPU shall be designed according to its MANUFACTURER standards.</p> <p>6.8. LOCAL CONTROLS</p> <p>6.8.1. The MOORING SYSTEM shall be provided with one or more local portable control panels, on each balcony, capable to operate the system functions, such as, to operate the chain jack, motorized turn-down sheave and chain stopper.</p> <p>6.8.2. As a general rule, the portable control shall reach in close distance and good view the respective equipment it is commanding. For example, the portable control that operates the chain jack and chain stopper shall reach the area around each chain stopper (in the balcony deck), and also the upper platform on the top of chain jack assembly.</p> <p>6.8.3. The communication of portable controls with the system may be cabled or wireless. In case of wireless option, the following shall be provided:</p> <ul style="list-style-type: none"> • A backup cabled communication. • The antennas shall be arranged so that, for each mooring bundle, the whole balcony extension receives a strong and adequate signal for the portable controls. This arrangement shall consider the FPSO arrangement, the presence of other equipment, and possible interferences on communication link. The datasheet of antennas and cables shall be submitted for OWNER's approval. <p>6.8.4. The portable control panels shall be provided with all necessary parameters and alarms for the system operation.</p> <p>6.8.5. The portable control joystick shall have proportional speed control for pay-out or pull-in with an automatic return to the neutral position (brakes on after coming to a stop) and a dead band around the 'zero speed' position to avoid unintended movements.</p> <p>6.8.6. The following controls and instrumentation shall be available on each mooring bundle. It is acceptable to have these parameters and alarms integrated on the portable control panels or in a dedicated local control console (LCC) for each bundle:</p> <ul style="list-style-type: none"> • Haul in, pay out, stopper controls and mode indications; • Chain stopper position; • Selection of the winch to be operated; • By-pass of the bitter end automatic stop of chain pay-out button, in glass protection; | | | |

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| <ul style="list-style-type: none"> • Chain speed; • Chain tension measurement: <ul style="list-style-type: none"> ○ Static, in the stopper structure through load pins or cells; ○ Dynamic, using hydraulic pressure as parameter; • Chain length measurement: <ul style="list-style-type: none"> ○ Chain outside fairlead; ○ Chain in locker, from chain jack winch; • Emergency stop; • HPU Pumps start and stop; • HPU emergency shut down switch independent of other functions; • LCC power switch; and • Alarms: <ul style="list-style-type: none"> ○ High tension in the line (static or dynamic); ○ Low tension in the line (static or dynamic); ○ High oil temperature; ○ Low oil level; ○ Automatic stop of pay-out (bitter end near turn down sheave); ○ Max chain out (5 m before automatic stop) ○ Min chain out (10 m before outer end of chain reaches fairlead); ○ Chain stopper load cell error. <p>6.8.7. After the end of guarantee period PACKAGER shall disclose to OWNER the password to access the PLC.</p> <p>6.8.8. The MOORING SYSTEM local controls, panels, PLC and accessories shall be designed with protection for the marine environment for requested design lifetime.</p> <p>6.9. CHAIN LOCKER</p> <p>6.9.1. At least four (4) fixed or movable chain lockers shall be provided, one for each mooring line bundle.</p> <p>6.9.2. The chain lockers shall be located out of the hull (chain lockers inside the hull are not accepted) and on a non-hazardous zone, in order to avoid the risk of fire due to sparking generated by friction between mooring chains and the deck itself. Document I-DE- – AREA CLASSIFICATION – GENERAL shall be verified.</p> <p>6.9.3. The chain locker design shall take into account chain pile settling movements and avoid jamming and twisting. Its geometry shall be designed so that there is no need for human intervention to accommodate the mooring chain inside of it, both on pull-in and pay-out operations.</p> <p>6.9.4. Each chain locker shall have a storage capacity of at least 300m (150m of installation chain plus 3 x 50m of top chain segments), without the need of manual distribution of chain inside the locker. This capacity shall be demonstrated by practical test to be executed on MANUFACTURER facilities or shipyard.</p> <p>6.9.5. Chain locker shall have means for internal access by operators (to be used only in extraordinary situations).</p> | | | |

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6.10. AUXILIARY HANDLING DEVICES

- 6.10.1. For each bundle, MOORING SYSTEM shall be equipped with all necessary integrated handling devices, such as monorails, auxiliary winch, bitts, lugs, and handling hoists to comply with all MOORING SYSTEM operations, such as, mooring lines hook-up, tensioning and de-installation, as required by item 6.1.6.
- 6.10.2. One (1) Tugger (Auxiliary) Winch shall be provided with a minimum pull capacity of 20T and a minimum cable length of 90.0m.
- 6.10.3. The MOORING SYSTEM shall be capable to pull-out the full length of the installation chain from chain locker to an AHTS vessel and to pull-in a new one (reverse operation). The Tugger (Auxiliary) Winch shall be suitable for this operation.
- 6.10.4. The final scope of supply will depend on mooring equipment arrangement and procedures adopted. Loose equipment, such as manual hoists, tirror and slings, shall not be included.

6.11. MOORING BALCONY STRUCTURE, FACILITIES AND ARRANGEMENT

- 6.11.1. Mooring balcony shall be illuminated on its deck area and the MOORING SYSTEM equipment, including inside the chain lockers and around the positioned chain jack to permit night hook-up operations. The illumination arrangement shall take special attention to prevent shadow zones behind the chain jack assembly and over the chain stopper (major working zone for operators).
- 6.11.2. Each Mooring balcony shall have a discard hole (additional to the slots that will be occupied by each mooring line) to allow pay-out or pull-in mooring chains to an AHTS vessel. Other discard arrangements may be proposed subject to OWNER's approval.
- 6.11.2.1. The discard hole shall be within reach of the chain jack assembly and be provided with dedicated supports for the chain jack assembly operation (for example, the use of turn down sheave and auxiliary winch).
- 6.11.2.2. The discard hole shall be provided with a dedicated chain stopper device, with a minimum load bearing capacity of 125T. This chain stopper device shall be, hydraulic-type (remotely operated) and shall allow the passage of LLC links. It is not required tension monitoring system for this chain stopper device.
- 6.11.2.3. Means shall be provided (such as a guide) to allow connecting a cable on the discard chain end link (positioned above balcony deck), pass thru the discard hole, go underneath the balcony structure until the balcony guard rail, where it should be fastened. This cable will assist to transfer the discard chain to AHTS vessel (similar to messenger wire rope).
- 6.11.2.4. The discard hole shall have the necessary guiding devices (such as a chain pipe) so that chain can be pulled-in/pulled-out without interference with other structures or mooring lines. It shall be considered that, below the discard hole,

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the discard chain is inclined towards the AHTS vessel, in pay-out operations (different than permanent mooring lines that pass vertically thru chain stoppers going to fairleads).

- 6.11.3. The balcony deck shall be made of steel plates. Tubular deck is not accepted. The number of openings/covers shall be minimized to avoid obstacles for operators when dislocating.
- 6.11.4. HULL SUPPLIER shall provide adequate cathodic protection for the MOORING SYSTEM and balcony structure.
- 6.11.5. The balcony structure shall be provided with holding points for the Tail Chain (item 6.16) and the excess of Messenger Wire Rope (6.15). Such holding points shall be positioned on the balcony external side (facing the sea), outside the guardrail, near the respective chain stopper. The Messenger Wire shall be arranged in a coil, organizing the excess of cable. Operators shall have access, from balcony deck, to fasten/unfasten the Tail Chain and Messenger Wire on their holding points. The fastening arrangement shall allow operators to safely release the Tail Chain/Messenger wire during hook-up operation (to be recovered by AHTS vessel). Outer side of balcony shall have enough room to allow operator to launch the Heaving Line to the AHTS vessel. Both legs of Messenger Wire (one going down to fairlead and other going up to coil holding point) shall be fastened, for example, using small diameter manila rope that shall break apart when AHTS vessel recovers the messenger wire. The described fastening arrangement is illustrated (schematic only) in Figure 2 below. Other arrangements may be proposed by HULL SUPPLIER/PACKAGER subject to OWNER's approval.



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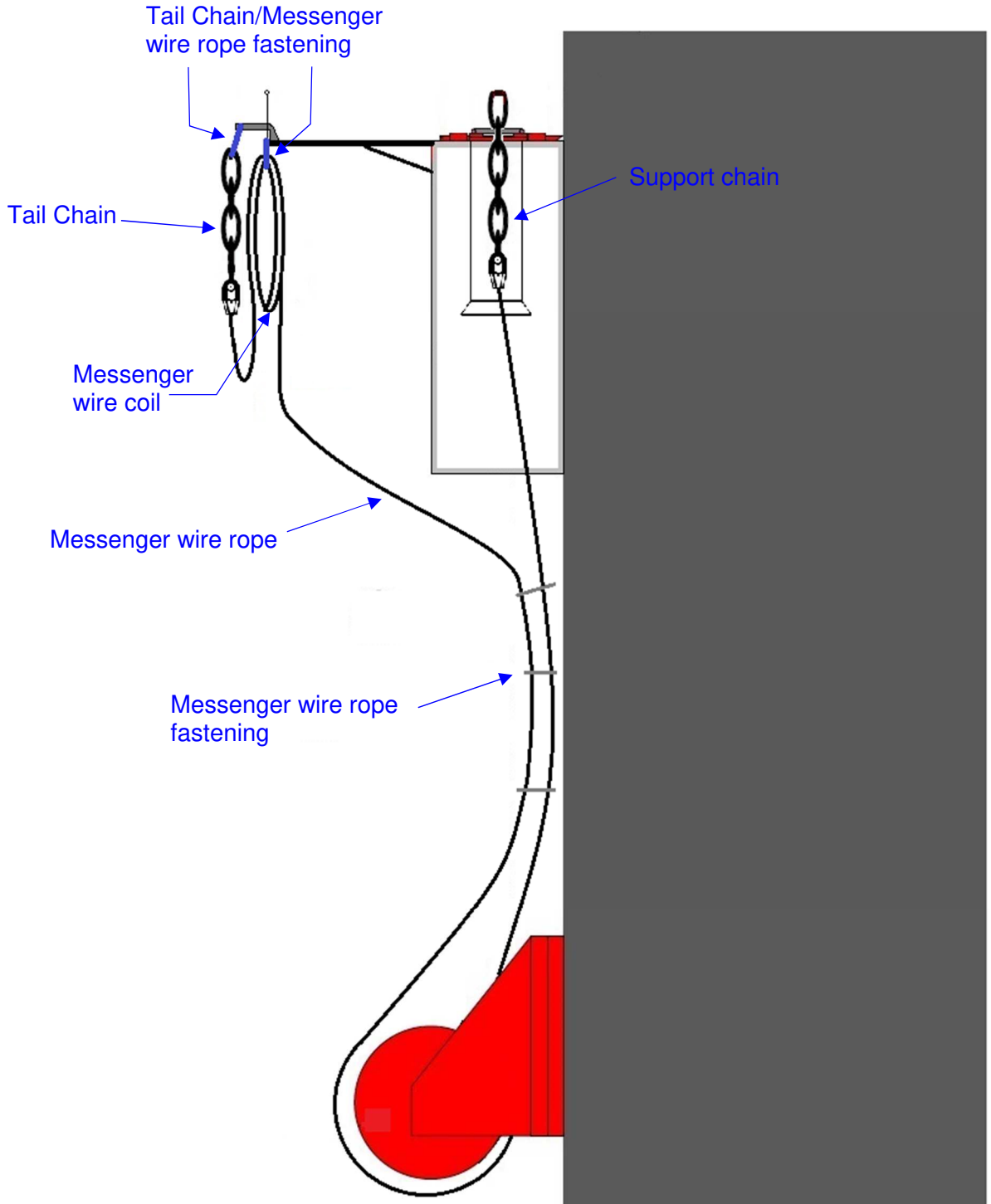



Figure 2 – Proposed Tail Chain and Messenger Wire Rope fastening arrangement

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6.12. MOORING INSTALLATION CHAINS AND ACCESSORIES

6.12.1. All accessories listed in this item shall be supplied with due certificates issued by the MANUFACTURER and by a recognized Classification Society. Such certificates shall be properly stored and available on the date of FPSO sail away from SHIPYARD.

6.12.2. The quantities of each item are defined in Table 2.

6.12.3. All mooring chains shall be supplied according to IACS W22 standard.

6.12.4. The installation chain, support chain and tail chain shall have the same diameter as the mooring line top chain segment, as informed on I-FD-MOORING LINES TOP CHAIN SPECIFICATION AND PRE-TENSION.

6.13. INSTALLATION CHAIN

6.13.1. Specification:

- Studless chain, R3 grade, length 150m, with common link on both ends;
- Diameter: same as mooring line top chain segment.

6.13.2. The Installation Chains shall be delivered installed on the Chain Lockers. The installation chain shall be put inside the chain locker using the MOORING SYSTEM itself, in order to prevent chain twist inside the locker, and also to test the system.

6.14. SUPPORT CHAIN

6.14.1. Specification:


- Studless chain, R3 grade, with common link on both ends;
- Diameter: same as mooring line top chain segment.
- Length: three (3) links.

6.14.2. The Support Chains shall be delivered pre-installed on each Chain Stopper (closed position) and its lower end shall be connected to the corresponding messenger wire rope (or pendant wire). The only function of the support chain is to work as a holding point (using chain stopper) for the messenger wire rope.

6.15. MESSENGER WIRE ROPE (OR PENDANT WIRE)

6.15.1. Specification:

- Six strand steel core wire rope, length 80m, with closed spelter socket on both ends.
- Minimum Break Load (MBL): 150T

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- Maximum diameter: 52mm

6.15.2. The messenger wire rope shall be delivered pre-installed passing thru each mooring fairlead, with one end connected to the support chain and the other end connected to the tail chain. The messenger wire function is to guide the installation chain from chain stopper thru the fairlead, and after, to the AHTS vessel. For messenger wire rope stowage arrangement, see item 6.11.5. The connecting shackle is described in item 6.18 (same for both ends).

6.16. TAIL CHAIN

6.16.1. Specification:

- Studless chain, R3 grade, with common link on both ends.
- Diameter: same as mooring line top chain segment.
- Length: 3 links

6.16.2. The Tail Chain shall be delivered supported by balcony structure as described in item 6.11.

6.16.3. The Tail Chain is used to allow holding the messenger wire rope by AHTS shark jaw.

6.17. HMPE CABLE

6.17.1. Specification:

- HMPE cable, diameter 1", length 70m, with eye type termination on both ends.
- Minimum Break Load (MBL): 50T


6.17.2. The HMPE cable will be connected to the tail chain (using a connecting shackle) to assist to pay-out the Tail Chain and Messenger Wire Rope to AHTS vessel on hook-up operation.

6.18. CONNECTING SHACKLE

6.18.1. Specification:

- A standard chain-connecting shackle, in which an external nut and nut-locking device restrains the pin, shall be used. Other types of connectors (Kenter links, Baldt links, etc.) are not acceptable.
- The shackle shall be suitable for assembly on support chain link, on the tail chain and on the closed spelter socket of messenger wire rope.

6.18.2. The connecting shackles will be used to connect support chain and messenger wire rope; messenger wire rope and tail chain; and tail chain and HMPE cable.

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6.19. LLLC LINK

6.19.1. Specification:

- LLLC links shall have the compatible external dimensions/geometry as the mooring lines top chain segment, so that they can suitably pass through mooring components such as fairleads, chain stopper, chain jack and turn down sheave.
- LLLC links shall be suitable for assembly on mooring line top chain segment.
- LLLC links shall have a minimum breaking load (MBL) of at least 45% of MBL of the mooring line top chain segment.

Note: Mooring line top chain specification is defined in I-FD-MOORING LINES TOP CHAIN SPECIFICATION AND PRE-TENSION.

6.19.2. The LLLC links will be used to connect the installation chain to the mooring line top chain segment (for hook-up final tensioning) and to connect installation chain and support chain.

6.20. HEAVING LINE

6.20.1. Specification:

- Material: Polyester or Nylon,
- Diameter 1/4", length 100m.

6.20.2. The Heaving Line will be connected to HMPE cable and will be thrown from FPSO to the AHTS deck.


6.21. TOWING RETRIEVAL WINCH (FWD/AFT)


6.21.1. In spite of being within MOORING SYSTEM package, the Towing Retrieval Winches are independent equipment of the rest of the system. Two (2) winches (FWD) shall be located in the forecabin towing rooms (PS/SB), while the other two (2) shall be located on the AFT main deck (PS/SB). Drawing I-DE-3010.2E-1350-964-P4X-001 - TOWING ARRANGEMENT shall be consulted for reference.


6.21.2. Towing Retrieval Winches shall be capable to recover the chafe chain and the rest of main bridle line from tug boat until the smit bracket in the FPSO deck, with the FPSO on its minimum draft.


6.21.3. Specification:

- Minimum pull capacity: 12T
- Minimum pull speed at maximum capacity: 4m/min

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| <ul style="list-style-type: none"> • Steel wire cable: compatible with winch capacity, minimum length of 200m, terminated with closed spelter socket. • Drive: Pneumatic • Command: Local | | | |
| 7. MOORING SYSTEM PROCEDURES | | | |
| 7.1. GENERAL | | | |
| <p>7.1.1. PACKAGER shall deliver specific procedures describing activities inside the FPSO and the MOORING SYSTEM operation to demonstrate that all necessary equipment/accessories are properly provided and arranged. As a minimum, it shall be provided specific step-by-step procedures for the MOORING SYSTEM operations described on items 6.1.6 and 6.5.10.</p> | | | |
| <p>7.1.2. These procedures shall be submitted for OWNER's approval and shall be part of the MOORING SYSTEM documentation.</p> | | | |
| <p>7.1.3. PACKAGER shall supply all temporary accessories, materials and components (with valid certificates) required by the hook-up procedures that are not included in Table 2.</p> | | | |
| 8. GENERAL REQUIREMENTS | | | |
| 8.1. ELECTRICAL REQUIREMENTS | | | |
| <p>8.1.1. Electrical equipment and material shall comply with requirements of the following references:</p> | | | |
| <p>a) I-ET-3010.00-5140-700-P4X-002 – SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.</p> | | | |
| <p>b) I-ET-3010.00-5140-712-P4X-001 – LOW-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS.</p> | | | |
| <p>c) I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.</p> | | | |
| <p>d) I-ET-3010.00-5140-700-P4X-001 – SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS</p> | | | |
| <p>e) I-DE-3010.00-5140-700-P4X-003 – GROUNDING INSTALLATION TYPICAL DETAILS.</p> | | | |
| 8.2. INSTRUMENTATION AND AUTOMATION REQUIREMENTS | | | |
| <p>8.2.1. PACKAGE instrumentation and control design shall fulfill the requirements of the following technical specifications:</p> | | | |

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| <p>a) I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.</p> <p>b) I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS.</p> <p>c) I-ET-AUTOMATION INTERFACE OF PACKAGE UNITS.</p> <p>d) I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANELS.</p> | | | |
| <p>8.3. PAINTING REQUIREMENTS</p> <p>8.3.1. Painting and coating in accordance with I-ET-3010.00-1200-956-P4X-002 – GENERAL PAINTING and DR-ENGP-I-1.15 COLOR CODING.</p> <p>8.3.2. All components shall be delivered fully painted/coated, except the chain links and any other otherwise indicated on this specification.</p> <p>8.3.3. The performed pre-treatment and complete coating shall be in accordance with the paint manufacturer’s data sheets.</p> | | | |
| <p>8.4. SKIDS LAYOUT AND FOUNDATION REQUIREMENTS</p> <p>8.4.1. PACKAGE components detailed on item 6 which are supplied assembled on skids shall follow the below minimum requirements.</p> <p>8.4.2. PACKAGE skid structure shall be designed to withstand the design conditions mentioned on item 4.4 and to ensure the lifting conditions on manufacturing site and shipyard. Lifting lugs shall be provided according to PACKAGER lifting procedure.</p> <p>8.4.3. The Skid main frame shall be all welded construction. Structural skid welds, including lifting facilities shall be continuous and shall comply with AWS D1.1 (structural welding code) and CS Rules. Skid structure shall be designed to be welded to the supporting structure unless otherwise specified.</p> <p>8.4.4. PACKAGE skid layout and arrangement shall be designed to provide sufficient access to pumps, instruments, equipment, and control panels so as to ease the operability and maintenance with safe conditions. Instruments and valves shall be installed on a suitable height to allow safe access for monitoring, operation, and maintenance.</p> <p>8.4.5. All necessary maintenance davits, monorails, padeyes or trolleys shall be provided to ensure the safe and easy maintenance conditions.</p> <p>8.4.6. Access ladders, platforms, gratings and any other access device shall comply with I-ET-3010.00-1352-130-P4X-001 - FLOOR GRATINGS, TRAY SYSTEMS AND GUARDRAILS MADE OF COMPOSITE MATERIALS, where non-metallic material is used. Metallic material is also acceptable. For grating requirements (metallic and non-metallic), I-DE-3010.2E-1351-140-P4X-001 – HULL GENERAL NOTES AND TYPICAL DETAILS shall be followed.</p> | | | |

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| <p>8.4.7. PACKAGE skid shall have a drip pan to collect drained water from the equipment with drain flanges for the connection with the Hull draining system.</p> <p>8.4.8. PACKAGE Equipment and components shall be located entirely within the skids / equipment base perimeter, including all equipment, piping, valves, electrical, instrumentation and controls.</p> <p>8.5. AVAILABLE ON BOARD</p> <p>8.5.1. For other utilities available onboard refer to I-RL–GENERAL SPECIFICATION FOR AVAILABLE UTILITIES.</p> <p>Note: The fresh water cooling referenced on this document refers to Topsides cooling system. For Engine room fresh water cooling system, refer to I-FD-3010.2E-5120-456-P4X-001 – ENGINE ROOM CENTRAL FRESH WATER COOLER (P-5120501A/B) and I-DE-3010.2E-5120-944-P4X-001 – ENGINE ROOM CENTRAL FRESH WATER COOLING SYSTEM.</p> <p>8.6. NAMEPLATES AND TAG NUMBERING</p> <p>8.6.1. PACKAGER / MANUFACTURER Equipment shall have nameplates in Brazilian Portuguese language, made of stainless steel AISI 316L, with 3 mm minimum thickness and fixed by stainless steel (AISI 316L) bolts or fasteners on visible and accessible location.</p> <p>8.6.2. Tagging of all instruments, electrical, mechanical and piping items, including valves, shall be carried out as detailed on I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.</p> <p>9. PACKAGE MANUFACTURING AND DELIVERY REQUIREMENTS</p> <p>9.1. GENERAL</p> <p>9.1.1. All materials and equipment supplied by PACKAGER / MANUFACTURER shall be brand new (not overhauled), field proven, free from defects and accepted by Owner and the Classification Society.</p> <p>9.1.2. Materials and equipment shall be manufactured according to internationally recognized standards for the offshore oil drilling and production industries and shall be in conformance with the Basic Design and Agreement specifications and requirements.</p> <p>9.1.3. Field proven definition: Systems and equipment shall demonstrate satisfactory operation at least in 3 floating offshore installation units, operating under process conditions (pressure, flow, capacity and similar fluids) for a minimum of 24,000 hours. For rotating equipment, they must demonstrate operation with fluid, flow and discharge pressure similar to the design. Unproven designs or prototypes (including components) without offshore service will not be accepted.</p> | | | |

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9.2. SPARE PARTS

- 9.2.1. For the hook-up operation, a set of spare parts shall be supplied considering the parts most susceptible to break or failure, according to MANUFACTURER's experience. Such parts shall include, for example, hydraulic hoses, hydraulic valves, key parts for motorized turn down sheave, load-cells/load-pins and so on. Such spare components shall prevent the need to exchange parts between equipment of different bundles.
- 9.2.2. A set of load-cells (or load-pins) for mooring line monitoring system, for two (2) chain stoppers, including any special tool required for load-cell (or load-pins) replacement. The appropriate documentation such as certificates, calibration curves, etc. shall be delivered printed together with the load-cells (or load pins).
- 9.2.3. For other PACKAGE spare parts, special tools and spare parts list recommended for two (2) years of operation refer to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.

9.3. WELDING


- 9.3.1. PACKAGE equipment, structures and piping welding, welding inspection, non-destructive testing (NDT), bolted joints assembly and piping fabrication and commissioning activities shall be performed in compliance with the following technical specifications:
- e) I-ET-3010.00-1000-970-P4X-002 – Requirements for NDT.
 - f) I-ET-3010.00-1000-955-P4X-002 – Requirements for Welding Inspection.
 - g) I-ET-3010.00-1000-955-P4X-001 – Welding.
 - h) I-ET-3010.00-1200-200-P4X-001 – Requirements for Bolted Joints Assembly and Management.
- I-ET-3010.00-1200-200-P4X-115 – Requirements for Piping Fabrication and Commissioning.

9.4. DOCUMENTATION

- 9.4.1. For the PACKAGE documentation and data-book requirements refer to EXHIBIT III – DIRECTIVES FOR ENGINEERING and to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.

9.5. INSPECTION AND TESTS

- 9.5.1. For PACKAGE inspection, tests, factory acceptance test (FAT) and inspection release certificate (IRC), refer to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.
- 9.5.2. For PACKAGE inspection and test plan (ITP) requirements refer to EXHIBIT VII – DIRECTIVES FOR QUALITY ASSURANCE SYSTEM.

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9.6. PRESERVATION, PACKING AND TRANSPORTATION

9.6.1. For PACKAGE preservation, packing and transportation requirements refer to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.