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INDEX OF REVISIONS									
REV.	DESCRIPTION AND/OR REVISED SHEETS								
0	ORIGINAL ISSUE								
A	MODIFIED ITEMS 3.3.1, 5.8.3.1, 5.8.3.3, 15.10 AND 15.12.								
B	GENERAL REVISION. REVISED WHERE INDICATED.								
	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	Aug/12/22	Dec/12/22	MAY/31/24						
EXECUTION	U4T4	U4T4	HR7O						
CHECK	CLYZ	HR7O	CLYZ						
APPROVAL	EGKA	CXM6	CXM6						
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INTERNAL

ESUP

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1 OBJECTIVE

- 1.1. This specification covers the minimum technical requirements and criteria for the design, engineering, materials, fabrication, inspection, testing, preparation of shipment, installation, pre-commissioning and commissioning of the FIRE WATER PUMPING UNITS as described below. The PACKAGES shall be supplied as complete, self-contained, skid-mounted packages, installed in dedicated fire rated enclosures (containers).
- 1.2. The PACKAGE is composed by the Units defined in the DIESEL HYDRAULIC FIRE WATER PUMPING UNIT Datasheet and this technical specification.

2 DEFINITIONS AND ABBREVIATIONS

2.1 DEFINITIONS

All terms and definitions are established in the latest revision I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS.

2.2 ABBREVIATIONS


CCR: Central Control Room
 CS: Classification Society
 CSS: Control and Safety System
 ECM: Electronic Control Module
 EGT: Exhaust Gas Temperature
 F&G: Fire and Gas
 FGS: Fire and Gas System
 FPSO: Floating, Production, Storage and Offloading (vessel)
 FRP: Fiber Reinforced Polymer
 HPU: Hydraulic Power Unit
 NPSH: Net Positive Suction Head
 PSV: Pressure Safety Valve
 SAE: Society of Automobile Engineers
 SOS: Supervision and Operation System
 UAM: Unit Alarm Malfunction
 UCP: Unit Control Panel
 P&ID: Piping and Instrumentation Diagram


3 NORMATIVE REFERENCES

All equipment shall comply with the requirements of this technical specification, Datasheets, documents, codes, and standards as stated below. All equipment parts and details not complying with any of these requirements shall be informed on a “Deviation List”. Otherwise, they shall be considered as “Agreed”, and so required.


3.1 CLASSIFICATION

- 3.1.1. PACKAGER/MANUFACTURER shall perform the work in accordance with the requirements of Classification Society.

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<p>3.1.2. PACKAGER/MANUFACTURER is responsible for submitting to the Classification Society all documentation in compliance with stated Rules.</p> <p>3.1.3. Classification Society rules may only be waived upon the formal approval from the Classification Society itself and from BUYER.</p> <p>3.2 APPLICABLE CODES, STANDARDS AND GOVERNMENTAL REGULATIONS</p> <p>3.2.1. The following codes and standards shall be fully complied with:</p>																																																									
<table border="0"> <tr> <td>NFPA 20</td> <td>Standard for the Installation of Stationary Pumps for Fire Protection</td> </tr> <tr> <td>NFPA 25</td> <td>Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems</td> </tr> <tr> <td>AISC 335-89</td> <td>Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design</td> </tr> <tr> <td>API-PR-2A</td> <td>PLANNING, DESIGNING, AND CONSTRUCTING FIXED OFFSHORE PLATFORMS WORKING STRESS DESIGN</td> </tr> <tr> <td>API STD 610</td> <td>Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries</td> </tr> <tr> <td>API STD 671</td> <td>Special-Purpose Couplings for Petroleum, Chemical and Gas Industry Services</td> </tr> <tr> <td>API STD 682</td> <td>Shaft Sealing Systems for Centrifugal and Rotary Pumps</td> </tr> <tr> <td>ISO 14691</td> <td>Petroleum, petrochemical and natural gas industries - Flexible couplings for mechanical power transmission - General-purpose applications</td> </tr> <tr> <td>ANSI/HI 14.6</td> <td>Rotodynamic Pumps for Hydraulic Performance Acceptance Tests</td> </tr> <tr> <td>ASME/BPVC Sec.VIII</td> <td>Rules for Construction of Pressure Vessels</td> </tr> <tr> <td>ASME IX</td> <td>Welding and Brazing Qualifications</td> </tr> <tr> <td>ASME B16.5</td> <td>Pipe Flanges and Flange Fittings</td> </tr> <tr> <td>ASME B31.3</td> <td>Process Piping</td> </tr> <tr> <td>API 7B-11C</td> <td>Specification for Internal-Combustion Reciprocating Engines for Oil- Field Service</td> </tr> <tr> <td>ASME PTC 17</td> <td>Reciprocating Internal-Combustion Engines</td> </tr> <tr> <td>ASTM D975</td> <td>Standard Specification for Diesel Fuel</td> </tr> <tr> <td>ISO 3046/ all parts</td> <td>Reciprocating Internal Combustion engines</td> </tr> <tr> <td>AWS D1.1</td> <td>Structural Welding Code, Steel</td> </tr> <tr> <td>ISO-1940/ parts 1& 2</td> <td>Mechanical Vibration-Balance Quality Requirements</td> </tr> <tr> <td>MARPOL Annex VI</td> <td>Regulations for the Prevention of Air Pollution from Ships</td> </tr> <tr> <td>API RP 14E</td> <td>Recommended Practice for Design and Installation of Offshore Production Platform Piping System</td> </tr> <tr> <td>IEC 60079/all parts</td> <td>Explosive Atmospheres</td> </tr> <tr> <td>IEC 60092-502</td> <td>Electrical Installation in Ships-Tankers-Special Features</td> </tr> <tr> <td>IEC 61508/all parts</td> <td>Functional safety of electrical/electronic/programmable electronic safety-related systems</td> </tr> <tr> <td>IEC 61511/all parts</td> <td>Functional safety - Safety instrumented systems for the process industry sector</td> </tr> <tr> <td>IEC 61892/all parts</td> <td>Mobile and Fixed Offshore Units – Electrical Installation</td> </tr> <tr> <td>IOGP S-711</td> <td>Specification for Diesel Engines</td> </tr> </table>				NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection	NFPA 25	Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems	AISC 335-89	Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design	API-PR-2A	PLANNING, DESIGNING, AND CONSTRUCTING FIXED OFFSHORE PLATFORMS WORKING STRESS DESIGN	API STD 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries	API STD 671	Special-Purpose Couplings for Petroleum, Chemical and Gas Industry Services	API STD 682	Shaft Sealing Systems for Centrifugal and Rotary Pumps	ISO 14691	Petroleum, petrochemical and natural gas industries - Flexible couplings for mechanical power transmission - General-purpose applications	ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests	ASME/BPVC Sec.VIII	Rules for Construction of Pressure Vessels	ASME IX	Welding and Brazing Qualifications	ASME B16.5	Pipe Flanges and Flange Fittings	ASME B31.3	Process Piping	API 7B-11C	Specification for Internal-Combustion Reciprocating Engines for Oil- Field Service	ASME PTC 17	Reciprocating Internal-Combustion Engines	ASTM D975	Standard Specification for Diesel Fuel	ISO 3046/ all parts	Reciprocating Internal Combustion engines	AWS D1.1	Structural Welding Code, Steel	ISO-1940/ parts 1& 2	Mechanical Vibration-Balance Quality Requirements	MARPOL Annex VI	Regulations for the Prevention of Air Pollution from Ships	API RP 14E	Recommended Practice for Design and Installation of Offshore Production Platform Piping System	IEC 60079/all parts	Explosive Atmospheres	IEC 60092-502	Electrical Installation in Ships-Tankers-Special Features	IEC 61508/all parts	Functional safety of electrical/electronic/programmable electronic safety-related systems	IEC 61511/all parts	Functional safety - Safety instrumented systems for the process industry sector	IEC 61892/all parts	Mobile and Fixed Offshore Units – Electrical Installation	IOGP S-711	Specification for Diesel Engines
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CONAMA NR 10 NR 12 NR 13 NR 26 NR 37	Brazilian Environment Ministry (Resolution 393/2007) Brazilian Secretary of Labor (Secretaria de Trabalho do Ministério da Economia – Norma Regulamentadora Nº 10, Segurança em Instalações e Serviços em Eletricidade) Brazilian Secretary of Labor (Secretaria de Trabalho do Ministério da Economia – Norma Regulamentadora Nº 12, Segurança em Instalações e Serviços em Máquinas e Equipamentos) Brazilian Secretary of Labor (Secretaria de Trabalho do Ministério da Economia – Norma Regulamentadora Nº 13, Caldeiras, Vasos de Pressão, Tubulações e Tanques Metálicos de Armazenamento) Brazilian Secretary of Labor (Secretaria de Trabalho do Ministério da Economia – Norma Regulamentadora Nº 26, Sinalização de Segurança) Brazilian Secretary of Labor (Secretaria de Trabalho do Ministério da Economia – Norma Regulamentadora Nº 37, Segurança e Saúde em Plataformas de Petróleo)		
3.2.2.	Government codes, regulations, ordinances, or rules applicable to the equipment in the country where it will be installed, shall prevail over the requirement of above specification, including reference codes and standards and/ or this engineering specification, only in those cases where they are more stringent.		
3.2.3.	PACKAGER/MANUFACTURER shall comply with any other government regulations stated in the Contract and not listed above.		
3.3 APPLICABLE DOCUMENTS			
The following design documents shall be fully complied with:			
3.3.1. TYPICAL DOCUMENTS			
<ul style="list-style-type: none"> • Process/Safety 			
I-ET-3010.00-5420-300-P4X-001	Fire Protection for Machinery Hoods		
I-ET-3010.00-5400-947-P4X-002	Safety Signaling		
I-ET-3010.00-1350-940-P4X-001	Systems Operation Philosophy		
I-ET-3010.00-5425-260-P4X-002	IG-541 Fixed Firefighting Total Flooding System		
DR-ENGP-M-I-1.3	Safety Engineering Guideline		
<ul style="list-style-type: none"> • Mechanical 			
I-ET-3010.00-1200-200-P4X-003	Design, Construction and Assembly of FRP Piping		
I-ET-3010.00-1200-251-P4X-001	Bolt Materials		
I-ET-3010.00-1200-431-P4X-001	Thermal Insulation for Maritime Installations		
I-ET-3010.00-1200-540-P4X-001	Requirements for Pressure Vessels Design and Fabrication		
I-ET-3010.00-1200-955-P4X-001	Welding		
I-ET-3010.00-1200-200-P4X-115	Requirements for Piping Fabrication Assembly and Commissioning		
I-ET-3010.00-1200-956-P4X-002	General Painting		

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I-ET-3010.00.1200-200-P4X-003 Design, Construction and Assembly of FRP Piping I-ET-3010.00-1200-751-P4X-001 Anodes Specification for Mechanical Equipment I-ET-3010.00-1200-300-P4X-001 Noise and Vibration Control Requirements DR-ENGP-I-1.15-R.3 Color Coding			
<ul style="list-style-type: none"> • Electrical 			
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 I-DE-3010.00-5140-700-P4X-001 Lighting Installation Typical Details 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-3010.00-5140-712-P4X-001 Low-Voltage Induction Motors for Offshore Units I-ET-3010.00-5140-797-P4X-001 Electrical System Automation Architecture 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-3010.00-5140-773-P4X-002 Specification For Generic DC UPS For Offshore Units I-ET-3010.00-5140-700-P4X-008 Specification For Lighting And Electrical Signalling For Offshore Units			
<ul style="list-style-type: none"> • Instrumentation and Automation 			
I-ET-3010.00-1200-800-P4X-002 Automation, Control and Instrumentation on Package Units			
<ul style="list-style-type: none"> • Naval 			
I-ET-3010.00-1350-960-P4X-001 Design Requirements – Naval Architecture			
<ul style="list-style-type: none"> • 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 I-ET-3010.00-1350-940-P4X-001 Systems Operation Philosophy			
<p>3.3.2. PROJECT SPECIFIC DOCUMENTS</p> <p>This section specifies documents that are referenced along the text and are part of a specific project. For that reason, the document's identification number is not yet defined and may vary according to project. The document title may also vary slightly from one project to another. Project's DOCUMENT LIST shall be consulted in order to verify the correct document number and title.</p>			
<ul style="list-style-type: none"> • Process/Safety 			
Diesel Hydraulic Fire Water Pumping Unit (Datasheet) General Specification for Available Utilities Piping and Instrument Diagram - Fire Water Pump Set Area Classification – General			
<ul style="list-style-type: none"> • Mechanical 			

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Piping Specification for Hull
 Topside's Mechanical Handling Procedures
 Hull Mechanical Handling Procedures

- **Electrical**
 Hull UPS and DC Systems One-Line Diagram

- **Instrumentation and Automation**
 Automation Interface of Package Units

- **Naval**
 Motion Analysis
 Metocean Data

- **General**
 General Arrangement

3.4 CONFLICTING REQUIREMENTS

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

3.5 CLASS APPROVAL AND CERTIFICATION


- 3.5.1. The FPSO hull is to be classified according to Classification Society Guide for Building and Classing Floating Production Installations.
- 3.5.2. Equipment certification and approval as required by the above rules is PACKAGER/MANUFACTURER's responsibility. PACKAGER/MANUFACTURER shall communicate directly with Classification Society and provide all documentation necessary to obtain approvals. PURCHASER shall be copied on all correspondence between PACKAGER/MANUFACTURER and Classification Society. PACKAGER/MANUFACTURER shall obtain approval for all parts of their work as required by Classification Society before shipment of the equipment to the shipyard.


4 DESIGN AND GENERAL TECHNICAL REQUIREMENTS

PACKAGER/MANUFACTURER shall be responsible for the complete design, fabrication, inspection, testing, and supply of the components and spares, in full compliance with the requirements of this specification, its attachments and all applicable codes, standards and regulations referenced and, where applicable, the requirements of the Classification Society.

4.1 SAFETY REQUIREMENTS

- 4.1.1. Personnel safety protection shall be provided according to Regulatory Standards (NR) by Brazilian Ministry of Labor.

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<p>4.1.2. Warning signs in Brazilian Portuguese language shall be provided where risk of personnel injury exist.</p> <p>4.1.3. Safety Signaling shall be in full compliance with I-ET-3010.00-5400-947-P4X-002 (SAFETY SIGNALLING).</p> <p>4.1.4. For area classification see the Drawing– AREA CLASSIFICATION – GENERAL.</p> <p>4.1.5. Mandatory safety items, as established in DR-ENGP-M-I-1.3 – SAFETY ENGINEERING GUIDELINE, are to be considered complementary requirements, to the pertinent extent. In case of items in conflict with this document, BUYER shall be consulted.</p> <p>4.1.6. Double block & bleed arrangements are required for isolation of equipment in piping classes of 300# and above.</p> <p>4.1.7. All safety signs, warning signs and notices shall be in Portuguese language.</p> <p>4.1.8. Rotating equipment outer parts, such as pulleys, couplings, belts and flywheels, shall have rigid protection and shall be capable of being easily removed.</p> <p>4.1.9. Container shall include an emergency door or emergency trapdoor.</p> <p>4.2 DESIGN LIFE</p> <p>4.2.1. 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 weather, corrosion, and fatigue or material failure.</p> <p>4.2.2. PACKAGER/MANUFACTURER shall provide a maintenance plan stating the expected time interval between major overhauls.</p> <p>4.2.3. Package design shall consider that the expected time between minor or intermediate corrective maintenance shall be at least 3 years, starting from commissioning phase.</p> <p>4.3 ENVIRONMENTAL CONDITIONS</p> <p>The supplied equipment shall be suitable for offshore application and environmental conditions, including atmospheric pressure, relative humidity, rainfall, air temperature, characteristic monthly values and wind motions, as defined in the METOCEAN DATA specification [document supplied by OWNER].</p> <p>4.4 MOTION AND ACCELERATION REQUIREMENTS</p> <p>4.4.1. PACKAGER/MANUFACTURER shall design the PACKAGE in accordance with the data on Motion Requirements, see the Report for – MOTION ANALYSIS [document supplied by OWNER].</p> <p>4.4.2. PACKAGE shall be able to withstand and operate in accordance with I-ET-3010.00-1350-960-P4X-001, “<i>Design Requirements – Naval Architecture</i>”.</p>			

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4.4.3. PACKAGER/MANUFACTURER shall design the PACKAGE to operate under the conditions of inclination established by Classification Society rules. These conditions may occur simultaneously.

4.5 DESIGN CONDITIONS

PACKAGER/MANUFACTURER shall design the PACKAGE for the full range of operational conditions as specified in the Datasheet DIESEL HYDRAULIC FIRE WATER PUMPING UNIT, and the Drawing PIPING AND INSTRUMENT DIAGRAM - FIRE WATER PUMP SET.

4.6 EQUIPMENT LOCATION

4.6.1. The FIRE WATER PUMPING UNITS shall be installed on board as follows:

4.6.2. Units comprising diesel engine driver, hydraulic power pack, booster pump, starting batteries and control panel over common bed, shall be supplied enclosed in fire rated container, self-ventilated, with diesel daily tank, firefighting and detection systems to be installed on the location defined on GENERAL ARRANGEMENT drawing.

4.6.3. The centrifugal lift pump driven by hydraulic power motor shall be installed inside of steel caisson extended from the upper deck until the vessel base line at hull side.

4.6.4. All electrical equipment shall be installed in non-hazardous area.

4.7 DESIGN REQUIREMENT

4.7.1. It is PACKAGER/MANUFACTURER's responsibility to submit to the CS the documentation in compliance with Rules in force.


4.7.2. All elements of the pump package, including sub-orders, shall be of field proven design and within the manufacturer's experience.

4.7.3. The pump suction-specific speed shall be calculated in accordance with Annex A of ANSI/API Std 610 and the suction-specific speed values shall not exceed 213 m³/s, rpm, m (11 000 gpm, rpm, ft).

4.7.4. The PACKAGE shall be capable to pump not less than 150 percent of the fire pump rated capacity at the lowest permissible suction pressure (refer to NFPA 20).

4.7.5. The net pump shutoff (churn) pressure plus the maximum static suction pressure, adjusted for elevation, shall not exceed the pressure for which the system components are rated (refer to NFPA 20).

4.7.6. Rated flow shall be greater or equal to 70% of the flowrate at best efficiency point for the selected impeller diameter.

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4.7.7. Pumps with constant speed drivers shall be capable of providing a head increase of at least 5% at rated capacity by installing a larger diameter impeller.

4.7.8. For foreign made equipment, the standard manufacturing parts (couplings, mechanical type seals, anti-friction bearings) shall be purchased from MANUFACTURERS with representative branches located in Brazil, with service parts and maintenance workshops.

4.7.9. Dissimilar materials in contact with an electrolyte shall be electrically isolated to avoid galvanic corrosion.

4.8 NOISE AND VIBRATIONS

4.8.1. Noise and vibrations limits shall be in conformance with the specification – NOISE CONTROL REQUIREMENTS. Noise data is required for the final proposal and after the FAT.

4.8.2. Any protections hoods used for noise reduction shall be made of SS 316L.

5 PACKAGE SPECIFICATION

5.1 SCOPE OF SUPPLY

5.1.1. The PACKAGE, henceforth referred to also as FIRE WATER PUMPING UNITS, shall be supplied as complete, self-contained, skid-mounted packages, installed as mentioned in the item 4.6 Equipment Location.


5.1.2. PACKAGER/MANUFACTURER is responsible for supplying complete and fully operative systems in accordance with the requirements of this specification, attachments and standards referenced herein and to meet the process duty as specified in the datasheet Diesel Hydraulic Fire Water Pumping Units.


5.1.3 PACKAGES shall be designed according to a “fail-safe start” philosophy and shall be continuously available to meet the specified duty, for 18 hours continuous operation at rated capacity, including all auxiliary systems and accessories required for start-up, safe and efficient operation, and maintenance of the PACKAGES.

5.1.4. Within 20 seconds after a demand to start, pump shall supply and maintain a stable discharge pressure (± 10 percent) throughout the entire range of operation. PACKAGES shall be able to start and reach the rated operation load, independent of any external power supply.

5.1.5. PACKAGES shall be complete in all respect and the scope of supply shall include but not be limited to the major equipment described in the datasheet DIESEL HYDRAULIC FIRE WATER PUMPING UNIT and the drawing PIPING AND INSTRUMENT DIAGRAM - FIRE WATER PUMP SET.

5.1.6. The fire water pumping system shall be provided with sea water supplied by FIRE WATER PUMPING UNITS driven by diesel engine.

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<p>5.1.7. The FIRE WATER PUMPING UNITS shall consist of a Centrifugal Lift Pump driven by Hydraulic Power Pack, supplying seawater to the Booster Pump (directly driven by diesel engine), which gives the required discharge pressure to the fire water header.</p> <p>5.1.8. The PACKAGES with all equipment, piping, valves, wiring, instruments and fittings shall be supplied complete, approved by CS and ready for erection on board.</p> <p>5.1.9. A hypochlorite injection line preventing the formation of marine microorganisms and bacteria shall be provided on the suction side of the lift pump. Hypochlorite injection piping into the lift pump suction shall be made of FRP. For FRP piping system requirements refer to I-ET-3010.00-1200-200-P4X-003 – DESIGN, CONSTRUCTION AND ASSEMBLY OF FRP PIPING.</p> <p>5.1.10. PACKAGER shall inform the recommended hypochlorite dosage to avoid obstruction by sea life while respecting the corrosion resistance limits of the submerged equipment materials.</p> <p>5.2 FIRE WATER PUMPS</p> <p>5.2.1. The design of both Lift Pump and Booster Pump shall comply with standards and reference documents of the item 3, especially the requirements of NFPA 20. The shaft sealing system shall be in accordance with API 610 and API 682 Standard with mechanical seals of cartridge type.</p> <p>5.2.2. The fire water pumps shall be selected according to requirements outlined in NPFA 20 and requirements of the datasheet DIESEL-HYDRAULIC FIRE WATER PUMPING UNIT.</p> <p>5.2.3. A mechanical seal with a throttling bushing shall be selected complying with API 682.</p> <p>5.2.4. Material selection for lift pumps and booster pumps shall be according to API 610 Table H Class D2 or Bronze Nickel Aluminum alloy.</p> <p>5.2.5. The Centrifugal Lift Pump of FIRE WATER PUMPING UNITS shall be installed submerged inside of steel caisson, of which connecting piping extends from FIRE WATER PUMPING UNITS elevation (refer to General Arrangement) until the vessel base line. Installation of Centrifugal Lift Pumps shall comprise of, at least:</p> <ul style="list-style-type: none"> a) Caisson b) Piping stack with top plate built-in power tube and discharge pipe. c) Hydraulic motor. d) Mechanical seal e) Spacers f) CuNi 90/10 suction strainer <p>5.2.6. The Centrifugal Lift Pumps shall be kept in continuous running at low speed when in stand-by.</p>			

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- 5.2.7. The Centrifugal Lift Pumps shall be designed with the suction considering the minimum draft and the variation of the sea wave height.
- 5.2.8. The Centrifugal Lift Pumps shafts seals shall prevent leakage of hydraulic oil to sea water and vice-versa.
- 5.2.9. Anti-corrosion systems, such as coatings and sacrificial anodes, shall be used where applicable to avoid crevice corrosion mechanisms in submerged lift pumps and guarantee 5 years of operational availability. The selection of sacrificial anodes material shall consider hydrogen corrosion risks if super duplex material is specified. Anti-corrosion systems are not required if pumps of Bronze Nickel Aluminum alloy are specified.
- 5.2.10. The booster pump shall be mounted on the same skid as the engine, hydraulic oil tank, hydraulic pump, controller, distribution panel, etc.
- 5.2.11. The booster pump shall be designed to withstand dry running for short periods, during the start-up. The pump shall have a 20% margin between any operating speed and the critical speed. PACKAGES shall have rigid shaft, operating below the first critical speed. PACKAGER/MANUFACTURER is responsible for ensuring that the critical torsional and bending speeds of the pump and drive unit, when coupled as a single unit, are below continuous operation speed.
- 5.2.12. Pumps operating in parallel shall have a minimum of 10% difference between the shut-off head and head at the operation point.
- 5.2.13. The NPSH required shall be at least 2m less than the NPSH available. Correction factors are not allowed. BUYER may accept differences between 1m and 2m, but a witnessed NPSH test shall be performed.
- 5.2.14. Surge drums equipped with pressure and vacuum relief valves shall be supplied to be installed on the discharge of each booster pump.
- 5.2.15. Submersible suction strainer's material shall be CuNi 90/10 alloy and it shall be electrically isolated. The strainer design shall provide flow velocities within CuNi 90/10 alloy velocity limit. Polymeric materials are not accepted.
- 5.2.16. The individual contribution for the parameter Head of the Lift Pump/Booster pump association shall be as close to 50/50 as possible, not exceeding 30/70.
- 5.2.17. Bearing housings shall be prepared for accelerometer or vibration probes installation for the booster pumps.

5.3 COUPLING AND GUARDS

- 5.3.1. Coupling shall be provided between the firewater pump and the diesel driver in compliance with the requirements of API 671. Universal joint (Cardan coupling) shall not be used.
- 5.3.2. Flexible coupling shall be used for flange-mounted drives and shall be in compliance with ISO 14691.

5.3.3. The coupling guard shall be in non-sparking material, fixed and shall be of sufficient rigid construction.

5.4 HYDRAULIC POWER PACK

5.4.1 GENERAL REQUIREMENTS

- 5.4.1.1. The Hydraulic Power Pack, located inside the container, shall be directly driven by the diesel engine.
- 5.4.1.2. The minimum cleanliness requirements of the fluid in the hydraulic power system shall be NAS 7 class.
- 5.4.1.3. The hydraulic power pack unit shall supply oil to the submerged hydraulic driven lift pump via hydraulic pipes, concentrically located inside lift pump pipe stack supplied by PACKAGER/MANUFACTURER.
- 5.4.1.4. The hydraulic unit shall include oil tank, hydraulic pumps, valves, including vent valve, coolers and instrumentation complete to power the lift pump plus auxiliary system such as air-cooling unit (The hydraulic system shall also feed the container/module room cooler unit in duty mode).
- 5.4.1.5. The system shall include an electric motor driven circulation pump to be in continuous operation during standby. Filtering for the low speed hydraulic system (standby operation) shall be provided.
- 5.4.1.6. The required hydraulic oil temperature shall be kept by cooler supplied together with the hydraulic unit.
- 5.4.1.7. The hydraulic oil system shall have an online oil condition monitoring device to enable real-time indication of oil contamination with water and metallic residue.
- 5.4.1.8. The hydraulic oil return line shall be protected from overpressure with a control logic. A PSV shall not be the only resource used to achieve this overpressure protection.

5.4.2 HYDRAULIC PUMP

- 5.4.2.1. The hydraulic power pack shall be provided with hydraulic oil pumps with sufficient capacity and discharge pressure to drive the hydraulic motor of the centrifugal lift pump in all load conditions, in combination with the hydraulic driven ventilation fans.
- 5.4.2.2. The hydraulic oil shall return to the pump/hydraulic tank via hydraulic oil cooler. To avoid overload of the system, a pressure relief valve shall be provided with a set at the desired pressure.

5.4.3 HYDRAULIC OIL HEAT EXCHANGERS

- 5.4.3.1. Returning oil from the hydraulic motors of the fire pumps shall be cooled before returning into the hydraulic oil tanks.

5.4.3.2. Cooling water may be supplied from the same fresh water cooling circuit, which supplies the cooling water to the diesel engines (heat exchangers in series or parallel).

5.4.3.3. The exchanger's materials shall be suitable for seawater service.

5.4.3.4. Pressure relief shall be provided for protection against overpressure.

5.4.4 HYDRAULIC OIL PIPING

5.4.4.1. All interconnecting hydraulic oil piping shall be of stainless steel type 316 L.

5.4.4.2. Pipe connections shall be of the flanged type according to SAE Standards. Compression type couplings and connectors arrange with male / female connectors may be used (Swagelok or equivalent). Double O-ring seals shall be provided.

5.4.5 HYDRAULIC OIL RESERVOIR

The hydraulic oil reservoir shall be supplied with capacity to storage the hydraulic oil system and shall be provided with:

- a) Pressure relief valve
- b) Pressure Gauge
- c) Thermometer
- d) Oil level sight glass
- e) Drain with self-closing valve

5.4.6 STRAINER

Continuous flow dual type with replaceable filtering elements with back flush valves shall be provided. The filtering elements shall be able to be cleaned or replaced online with the system in operation.

5.5 DIESEL ENGINE

5.5.1. The Diesel Engine, including its controllers and accessories, shall comply with chapters 11 and 12 from NFPA 20, "Standard for the Installation of Stationary Pumps for Fire Protection", IOGP S-711 Specification, main Classification Societies and National Authorities.

5.5.2. The diesel engines shall be fitted with an electronic control module (ECM) with redundancy (as prescribed in NFPA 20) to carry out and control the fuel injection process and other engine parameters / variables. The alternative (or secondary) ECM shall be mounted and connected permanently so that the motor can produce its full rated power in the event of failure of the primary ECM.

5.5.3. Diesel engines shall have sensors installed to monitor the individual exhaust temperature of the cylinders (EGT).

5.5.4. Diesel engines shall be designed and supplied with electronic module facilities to allow starts under suitable speed rate. Default value shall be set on factory, in a

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range of 120 to 150 RPM/s, considering nominal speed in 1800 RPM, but prone to be adjusted by qualified personnel at field.

- 5.5.5. The speed rate above mentioned shall strictly comply with NFPA 20 Standard maximum limit for diesel engine start and beginning of effective pump running mode.
- 5.5.6. The diesel engines shall be of approved design and rated to supply the power required by the pump sets in all possible operating and load conditions during starting and running of the pumps and for the power supply for the ancillary equipment.
- 5.5.7. The diesel engine shall be fitted with auxiliary equipment to comply with the requirements of NFPA 20, main classification societies and national authorities.
- 5.5.8. Diesel engines shall be designed for heavy duty, in continuous operation, with fresh water cooling circuit, four-stroke cycle, and turbocharged, capable of cold or hot start-up under load. All engine components shall be suitable for marine environment.
- 5.5.9. The coupling between the diesel engines and the pumps shall be a flexible coupling mounted directly on the crankshaft.
- 5.5.10. Means shall be provided to prevent engine damage caused by back flow in case of possible check-valve failure. (Either a “freewheel” coupling or a flywheel coupling). In addition, an alarm shall be fitted to detect reverse rotation.
- 5.5.11. The diesel engines shall run with Marine Diesel Oil.
- 5.5.12. The diesel engine power (kW) ratings, curves and performance data shall be furnished by SUPPLIER to BUYER collated in the bid.
- 5.5.13. The engine shall be capable of starting up cold or hot under load, with no dependency on external electric energy supply. The diesel engine shall be equipped with a jacket water heating resistance system, aiming to maintain the temperature at 60 °C, in order to be able to start under load.
- 5.5.14. According to the item 8.3.4 of NFPA 20 – Diesel Fuel Testing and Maintenance - diesel fuel shall be tested for degradation no less than annually. Fuel degradation testing shall comply with ASTM D975, Standard Specification for Diesel Fuel Oils.
- 5.5.15. PACKAGER/MANUFACTURER shall provide a sample take inside the PACKAGE for Diesel Fuel testing.
- 5.5.16. The diesel engine shall comply with MARPOL annex VI.
- 5.5.17. Each engine shall be supplied complete with the following items:
- Starting System
 - Two independent electrical starting systems by battery;
 - Electrical 24 V DC starting motors (2 x100%).

- Two battery banks vented lead acid type (valve regulated batteries are not acceptable, based on IEC 61892-6). Each battery bank shall be sized, based on calculations, to have capacity to carry the loads defined in NFPA 20 for 72 hours of standby power followed by six consecutive cycles of 15 seconds of cranking and 15 seconds of rest, without ac power being available for battery charging;
- Two battery chargers 24 VDC.
- Fuel System
 - Diesel oil daily tank and compensation tank whenever necessary;
 - The fuel oil tank shall be designed with sufficient capacity to operate the system for 18 hours continuous operation at rated capacity;
 - Positive displacement mechanical injection pump driven by diesel engine shaft, with injection nozzles for the various cylinders;
 - Manual priming pump for emergency use;
 - Flexible fuel lines;
 - Flexible connection with fire-protection, built of AISI 316L stainless steel;
 - Fuel filter with replaceable elements, with valves for back flushing, continuous flow type. Fuel filters for solid particles shall be of duplex type, with insert replaceable without interrupting the fuel supply to the engine;
 - The tank shall be fitted with flame arrestor, overflow line, level gauge and transmitter with high and low level alarms, sampling valve, filling valve and emergency shut off valve remotely operated from outside of the container.
- Lubricating System
 - Gear-type main oil circulation pump driven by the engine shaft;
 - Hand-operated pre-lubrication auxiliary pump and oil pan drain;
 - Duplex lube oil filter of cartridge type with disposable elements. Filter cartridges shall be exchangeable without interrupting the oil supply to the engine;
 - All piping for interconnection, valves, drains and other auxiliaries inside the skid;
 - Pre-lubricating pump driven by DC electric motor;
 - Pre-lube oil pump with activation prior to starting the engine.
 - Online oil condition monitoring capable of detecting solid particles and water.
- Cooling System
 - The engine jacket and lube oil cooling system shall be of the closed circuit type, including a circulation pump driven by the engine shaft and a reliable engine jacket temperature regulating device;
 - Expansion tank for each coolant fluid circuit, with level gauge and transmitter, with low level alarm. An opening shall be provided in the expansion tank for filling the system, checking coolant level and adding make-up coolant when required. Only clean or treated coolant, as per Engine Manufacturer's recommendation, shall be used in the coolant system;
 - Cooling of the coolant fluid shall be accomplished by using a heat exchanger, which shall exchange heat with sea water from the firewater pumps discharge line. Coolant fluid pressure shall be higher than sea water pressure;
 - Each cooling circuit shall have a heat exchanger;
 - The seawater outlet shall be anti-siphon and discharge overboard. The exchanger shall be of all suitable material for seawater services.
- Exhaust System
 - Ducts, exhaust gas, transition piece and expansion bellows;
 - 25 dB(A) silencer with spark arrestor;
 - Exhaust system shall be sized in such a manner as to avoid engine performance being jeopardized by backpressure;



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- Engine exhaust manifold shall be effectively insulated, so that the maximum external temperature, with ambient temperature 45°C shall not exceed 60°C in parts with access by personnel. Insulation shall be done in a way to permit easy disassemble and reassemble after inspection/maintenance;
- Protection against water ingress, with valve and drain to prevent condensation from returning to the engine.
- Combustion Air System
 - The combustion air inlet to the diesel engine shall be routed through the container roof or sidewall, and equipped with a low velocity two-stage filter coalescer;
 - To comply with noise requirements, or if otherwise required, a combustion exhaust gas silencer can be installed downstream the air filters.
- Others
 - Coupling and Turning gear;
 - Electronic Fuel Management Control;
 - Resilient Mounts for diesel engine shall be designed to withstand static loads as well as dynamic loads arising from FPSO motions. It shall also isolate vibration to the surrounding structures;
 - Diesel Engine shall be supplied with a speed adjustment device for all operating modes of the pump, such as idle speed, rated speed (rated point), as per DIESEL HYDRAULIC FIRE WATER PUMPING UNIT datasheet, full speed (according to NFPA 20 requirement), maintenance and performance test;
 - One battery bank vented lead acid for control (valve regulated batteries are not acceptable, based on IEC 61892-6);
 - One battery charger 24 VDC for control, fed from control panel and from shaft-driven alternator. As an alternative to shaft-driven alternator, a 100% redundant battery charger for control voltage may be used;
 - Pre-heating water system driven by electric motor and heated by resistors;
 - Acoustic and erosion/corrosion protection;
 - Control Panel and Systems;
 - Common skid for diesel engine, driven equipment and auxiliaries.


5.5.18. PACKAGER / MANUFACTURER shall supply the atmospheric emissions report (on demand) referencing applicable regulatory rules.

5.5.19. PACKAGER / MANUFACTURER shall design and supply the diesel engine for outdoor installation in saline atmosphere.

5.6 PIPING

5.6.1. All piping, with water (sea, cooling, hot) as process fluid, shall be designed, fabricated, and inspected in accordance with ASME B31.3 and the specification for PIPING SPECIFICATION FOR HULL. Threaded connections shall not be used.

5.6.2. All connections shall be located at skid edge and provided with flanged connections according to ASME B16.5 and the specification for PIPING SPECIFICATION FOR HULL. Locations, size and rating of all connections shall be clearly defined by PACKAGER/MANUFACTURER.

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5.6.3. All auxiliary piping shall terminate with block valves at the edge of the skid and shall be designed to allow easy disconnection of pipe work.

5.6.4. After completion of fabrication, all fabricated pipe spools shall be internally and externally cleaned to remove all loose scale, weld spatter, sand, and other foreign materials.

5.6.5. PACKAGER/MANUFACTURER shall check and approve all piping with respect to stresses, vibration and layout. Piping support shall be provided at skid edge.

5.6.6. Spectacle blinds shall be supplied and assembled for maintenance and testing.

5.7 INSTRUMENTATION

5.7.1 General

5.7.1.1. The FIRE WATER PUMPING UNITS package is classified according to the specification for (AUTOMATION INTERFACE OF PACKAGED UNITS).

5.7.1.2. The PACKAGE automation, control and instrumentation shall fully comply with I-ET-3010.00-1200-800-P4X-002 – Automation, Control and Instrumentation on Package Units and I-ET-3010.00-1350-940-P4X-001 – Systems Operation Philosophy.

5.7.1.3. PACKAGER/MANUFACTURER shall provide, as part of the PACKAGE, instrumentation which makes it possible the performance curve testing to be in compliance with ANSI 14.6.

5.7.2 Control Panels

5.7.2.1. The unit control panel shall be according to the Classification society and relevant NFPA-20 regulations.

5.7.2.2. The FIRE WATER PUMPING UNITS shall be started:


- Automatically by pressure drop in the firewater header with time delay (SUPPLIER shall supply instruments as loose items to be fitted prior the commissioning tasks);
- Automatically from the CSS-FGS in the CCR upon confirmed fire;
- Manually remote from CCR;
- Manually from the local Pump unit control panel.

5.7.2.3. The FIRE WATER PUMPING UNITS shall be stopped:

- Locally from the Pump Units Control Panel;
- Automatically in case of diesel engine overspeed.

5.7.2.4. The fire water pumping start-up shall be inhibited by the following condition:

- Confirmation of combustible gas at the combustion air intake (confirmation of combustible gas at the Unit's room ventilation air intake shall not inhibit fire-water pump start-up);
- Confirmation of fire inside the containerized pump room.

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5.7.2.5. The following local alarms on panel shall be incorporated:

- Start attempt controller (3 x start);
- “AC healthy” indication lamp;
- 2x “loss of starting battery charger output”;
- 2x “starting battery low voltage” indicator (lamp + alarm);
- “Installation on demand” indication lamp;
- “Diesel engine running” indication lamp;
- “Start failure/overcrank diesel engine” (lamp + alarm);
- “Lube oil low pressure ” (lamp + alarm);
- “Cooling water high temperature” (lamp + alarm);
- “Cooling water low pressure” (lamp + alarm);
- “Cooling water low level” (lamp + alarm);
- “Overspeed” SHUTDOWN (lamp + alarm);
- “Fuel oil tank level low” (lamp + alarm);
- “Hydraulic oil level low” SHUTDOWN (lamp + alarm);
- TEST – REMOTE – MANUAL – OFF selection switch;
- Common alarm combining all above alarms (UAM).

5.7.2.6. It shall be possible to inhibit automatic start of fire pump, using a hardwired external signal from F&G System.

5.7.2.7. Local start shall always remain possible even when the pumps automatic start is inhibited.

5.7.2.8. Relays shall be provided in the control panels to isolate the remote start and stop contacts from the control panel’s voltage.

5.7.2.9. For a list of signals exchanged between FIRE WATER PUMPING UNITS and the automation systems, consult the specification for AUTOMATION INTERFACE OF PACKAGED UNITS.


5.7.2.10. CONTRACTOR shall demonstrate that alarms and trips can be tested without the need to disconnect piping and/or electrical connections or use jump wires.

5.8 ENCLOSURE

5.8.1 General

5.8.1.1. Each FIRE WATER PUMPING UNITS package shall be mounted in a complete fire rated enclosure, of which "A" class division shall be defined in accordance with the criteria established by DR-ENGP-M-I-1.3 SAFETY ENGINEERING GUIDELINE.

5.8.1.2. Container shall be sized for housing a totally independent fire pump system and all other auxiliary equipment and systems, including mechanical handling devices, internal lighting, HVAC system, fire protection systems (fire, heat & gas detection), firefighting systems, side doors (one for each side) with viewing windows, roof and/or wall opening to allow maintenance access to all parts of equipment, lifting beams and removable panels for overhauling the diesel engine and other components.

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- 5.8.1.3. Container shall be designed to resist all sling forces, including both horizontal and vertical components of the applied sling angle (sling angles shall be within between 50 and 90 degrees with the horizontal plane).
- 5.8.1.4. Container shall be designed with lifting facilities to permit the entire package to be lifted by crane as a single point lift for transportation and installation.
- 5.8.1.5. The enclosure shall comply with the item 4.8 of this specification.

5.8.2 HVAC System

- 5.8.2.1. Enclosure HVAC system shall be provided by PACKAGER/MANUFACTURER to meet normal operation (diesel engine in stand-by) and firefighting operation condition (diesel engine running).
- 5.8.2.2. SUPPLIER shall supply a complete HVAC system for the enclosure, including inlet/outlet filter and dampers, ducts and controls. At least two separate systems shall be provided as follows:
- System for normal operation (diesel engine in stand-by)
 - This system shall supply air to the enclosure at a minimum of 6 (six) air changes per hour and shall maintain the minimum positive pressure as required by Classification Society.
 - Exhaust may be via louvered pressure-relief outlets to atmosphere. Rates of ventilation shall take into account the residual heat dissipation immediately following the engine shutdown.
 - Fire/gas damper logic shall be fully executed in packaged unit UCP, on a separate PLC for interlocking/fire&gas purposes. The signals defined on the specification for AUTOMATION INTERFACE OF PACKAGED UNITS shall be represented in the main supervisory system of the FPSO (SOS).
 - System in firefighting operation (diesel engine running)
 - This system shall provide the cooling air and the required combustion air, and is to be powered by the engine (independent from platform electrical generation). Fire/gas dampers in this case shall be interlocked with engine operation.
 - An air cooling unit may be included to keep the temperature inside the enclosure at an acceptable level for safe operation of the unit.
 - An inlet for dedicated combustion air to the diesel engine shall be provided.
 - Combustion air ducting shall be routed to the container roof or sidewall and fitted with low velocity two-stage coalescent filter and fire damper with shut-off device.

5.8.3 Fire Fighting and F&G Detection System

- 5.8.3.1. Fire detection and extinguisher system shall be installed to detect and extinguish a potential fire inside the container. Type of extinguisher system shall be water mist or clean agent.
- 5.8.3.2. A F&G detection system, as well as, a firefighting system shall be foreseen for each FIRE WATER PUMPING UNITS.

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<p>5.8.3.3. The firefighting system shall be supplied complete by PACKAGER/MANUFACTURER, comprising firefighting medium, piping, valves, fittings and fire extinguishing diffusers.</p> <p>5.8.3.4. The F&G detection systems, with necessary flame detectors, heat detectors and gas detectors shall also be supplied and connected to the pump control panel.</p> <p>5.8.3.5. Fire Fighting and Fire Detection System specification shall follow requirements of I-ET-3010.00-5420-300-P4X-001 - Fire Protection for Machinery Hoods.</p>			
<p>5.9 MAINTENANCE HANDLING</p> <p>5.9.1. PACKAGER/MANUFACTURER and SUPPLIER shall follow the requirements for maintenance handling on TOPSIDE'S MECHANICAL HANDLING PROCEDURES and HULL MECHANICAL HANDLING PROCEDURES. PACKAGER/MANUFACTURER shall supply spreader bars and specific handling devices for installation and maintenance with the applicable certificates.</p> <p>5.9.2. All necessary maintenance lift beams shall be provided to facilitate safe and easy maintenance. All lifting beams shall overhang by at least 1 m.</p>			
<p>5.10 SKIDS</p> <p>5.10.1. PACKAGER/MANUFACTURER shall design and construct a steel structural skid to accommodate equipment within PACKAGER/MANUFACTURER'S scope of supply.</p> <p>5.10.2. The skid shall be of rigid construction, which will not distort during hoisting, operation and shipment and shall withstand all moments and forces due to the vessel motion.</p> <p>5.10.3. PACKAGER/MANUFACTURER shall design all structural components, including calculation report and detailing drawings. PACKAGER/MANUFACTURER shall fabricate and assembly the support structures in accordance with AISC 335-89 - SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS ALLOWABLE STRESS DESIGN AND PLASTIC DESIGN and API-PR-2A - PLANNING, DESIGNING, AND CONSTRUCTING FIXED OFFSHORE PLATFORMS WORKING STRESS DESIGN. Lifting pad eyes shall be designed in accordance with project Classification Society or Marine Warranty Surveyor Rules. Any slings, spreaders bars, provided by PACKAGER/MANUFACTURER, shall be furnished with applicable certificates.</p> <p>5.10.4. Welding shall be carried out with procedures and operators qualified in accordance with the ASME section IX. Welding shall not be performed before qualified welding procedure, etc. is approved. Intermittent fillet welds are not permitted.</p> <p>5.10.5. The skid shall be designed:</p>			

- So that it is self-draining and after installation, fluid shall not accumulate between the skid beams unless designed to be a drip tray.
- Drip trays shall include drain connections in different locations.
- With skid main beams braced, as required, to ensure rigidity and be designed to withstand the anticipated (torsional) vibration produced by the operating equipment and the stresses created by the ship motions.
- With the floor made of plate material with a raised non-slip tread, where applicable.
- With welds underneath skid beams ground flush.
- With 2 diagonally opposed earthing bosses.
- The arrangement of equipment, piping and superstructure shall be such that the centre of gravity coincides approximately with the geometrical centre of the skid.
- Mounting surface of pedestal where booster pumps are mounted on shall be levelled longitudinally and transversely to within 0.4 mm per meter in the factory. Levelling check report shall be provided on section III (Quality section) of the Data book.

5.11 PRESSURE VESSELS

- 5.11.1. All pressure vessels shall comply with the requirements of NR 13 – Brazilian Labor Ministry Rules and comply with requirements of I-ET-3010.00-1200-540-P4X-001 - Requirements for Pressure Vessels Design and Fabrication.
- 5.11.2. Requirements of NR 13 Brazilian Regulation “Caldeiras, Vasos de Pressão, Tubulações e Tanques Metálicos de Armazenamento” shall be applied.
- 5.11.3. Pressure vessels, including filters, heat exchangers, moisture separators, among other vessels classified as such in ASME VIII, division 1, shall conform to the requirements of this design code.

5.12 PAINTING

- 5.12.1. Paint System for external coating shall comply with requirements of I-ET-3010.00-1200-956-P4X-002 – General Painting.
- 5.12.2. Color code adopted shall be in accordance DR-ENGP-I-1.15 – Color Coding.
- 5.12.3. All components shall be delivered fully painted/coated.
- 5.12.4. The performed pre-treatment and complete coating shall be in accordance with the paint manufacturer’s datasheets.
- 5.12.5. Defects arising within the guarantee period shall be subject to an allowance of 1%, representing wear and tear. For system failure in excess of this, PACKAGER/MANUFACTURER’s liability shall include complete pre-treatment and repainting.

5.13 ELECTRICAL REQUIREMENTS

- 5.13.1. The DC system source, included in the unit’s scope of supply shall comprise:

- 3 x Battery 24 VDC for Fire Water Pump (for each pump: 2 for starting unit, 1 for control)
- 3 x Battery Charger 24 VDC for Fire Water Pump (for each pump: 2 for starting unit, 1 for control)

5.13.2. Electrical equipment and material shall comply with requirements of 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 and I-ET-3010.00-5140-773-P4X-002 Specification For Generic DC UPS For Offshore Units.

5.13.3. Electrical equipment shall be manufactured and tested in compliance with Classification Society and IEC requirements, unless otherwise stated.

5.13.4. Electric motors shall comply with I-ET-3010.00-5140-712-P4X-001 - Low-Voltage Induction Motors for Offshore Units.

5.13.5. Equipment, accessories, piping and structures shall be grounded according to requirements of IEC 61892-6, IEC 60092-502, I-ET-3010.00-5140-700-P4X-001 - Specification for Electrical Design for Offshore Units and I-DE-3010.00-5140-700-P4X-003 - Grounding Installation Typical Details. Besides these standards, for installations in hazardous area, the grounding requirements of IEC 61892-7 shall be complied with.

5.13.6. PACKAGER shall design and supply the PACKAGE in compliance with I-ET-3010.00-5140-700-P4X-003, "*Electrical Requirements for Packages for Offshore Units*", I-DE-3010.00-5140-700-P4X-001, "*Lighting Installation Typical Details*" and I-ET-3010.00-5140-700-P4X-008, "*Specification for Lighting And Electrical Signalling For Offshore Units*".

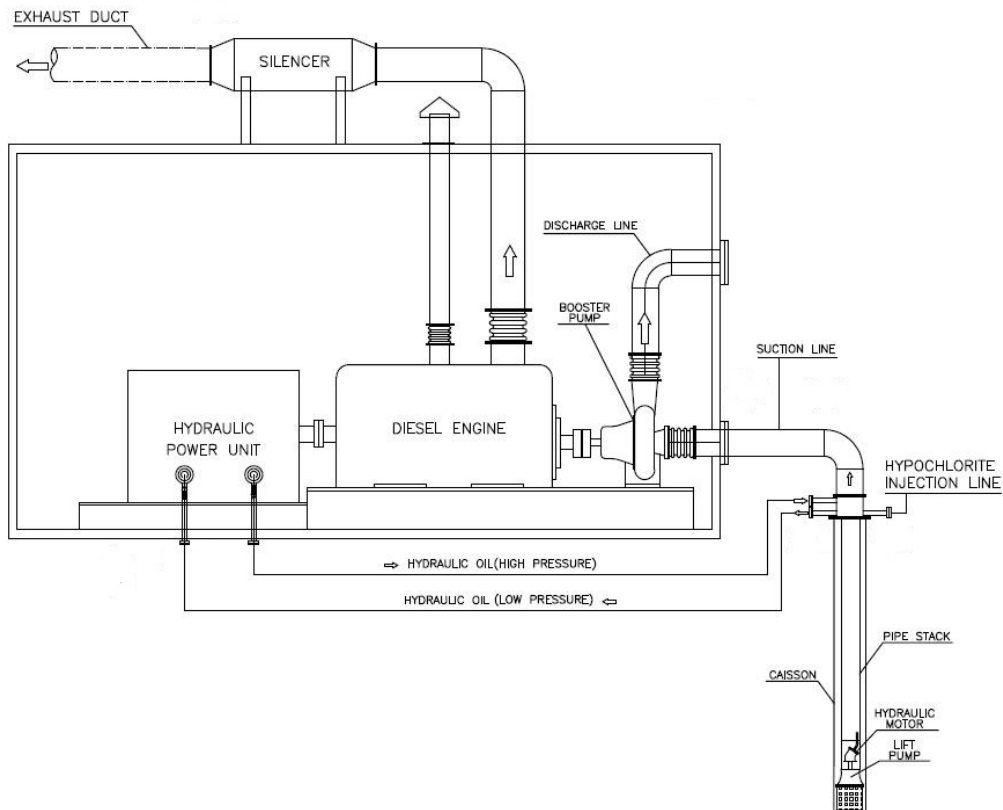
5.13.7. Electrical equipment shall be fed from Package Power and Control Panel.

5.14 MANUFACTURING

5.14.1. All materials and equipment shall be new and from Company's Approved Manufacturer's List. Any materials used in the fabrication of this equipment from an unapproved manufacturer shall be rejected, removed and replaced at PACKAGER/ MANUFACTURER's expense.


5.14.2. All equipment and components shall be manufactured up to two years before the delivery date at most.

5.15 UNIT SKETCH



6 NAMEPLATES

- 6.1. PACKAGER/MANUFACTURER shall attach corrosion resistant stainless steel type 316 nameplates on each item of equipment in an accessible location, fastened with corrosion resistant stainless steel type 316 pins, and in Brazilian Portuguese language.
- 6.2. For pressure vessels, columns and filters the nameplates shall be according to I-ET-3010.00-1200-540-P4X-001 – Requirements for Pressure Vessels Design and Fabrication.
- 6.3. For the other equipment, the nameplates shall include, as a minimum, the following information:
 - Petróleo Brasileiro S.A. – PETROBRAS;
 - Purchase order number;
 - Manufacturer and year of build;
 - Tag number;
 - Service;
 - Serial number;
 - Main data for design, operation and testing (Power, Pressure, Volume, Temperature, Rotation, Flow rate), where applicable;
 - Specific requirements;
 - Installation identification;
 - Driver power rating and speed, where applicable;

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- Design code;
- Empty weight;

6.4. Valves, instruments and orifices shall have a nameplate with tag number and serial number.

6.5. NR-13 information (if applicable). All technical data on the nameplates shall be shown in metric units, except for pressure which shall be indicated in 'bar'.

6.6. Ancillary equipment shall have nameplates in accordance with respective technical specifications defined on section 3.

7 TAG NUMBERING

7.1. For tag rules, see the I-ET-3000.00-1200-940-P4X-001 - Tagging Procedure for Production Units Design and I-ET-3010.00-5140-700-P4X-001 - Specification for Electrical Design for Offshore Units.

7.2. Tagging of all instruments, electrical, mechanical and piping items, including valves, shall be carried out by PACKAGER/MANUFACTURER and confirmed by BUYER.

7.3. Valves, instruments and orifices shall be tagged with the applicable number only.

7.4. All tag plates shall be made from AISI 316 stainless steel material.

8 SPARE PARTS

8.1. PACKAGER/MANUFACTURER shall provide a list of recommended spare parts for commissioning, start-up and 2 (two) years of operation in accordance with CS requirements, as a minimum.

8.2. In the case that CS has no requirements but only a guide list for spare parts, this guide list shall be understood by PACKAGER/MANUFACTURER as a mandatory requirement together with manufacturer's recommendation and shall be furnished at no extra cost to BUYER.

8.3 Spare parts required for NR-13 tests shall be provided.


9 SPECIAL TOOLS

All special tools necessary for the installation, alignment, operation or maintenance of the equipment shall be supplied with the delivery of the equipment. Special tools and CONTRACTOR personnel required for installation and/or commissioning shall be specified as a separate cost.

10 CERTIFICATION REQUIREMENTS

10.1 CLASS CERTIFICATION

A Classification Society Certificate shall be supplied to attest compliance of the whole Package with the Rules requirements.

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10.2 MATERIAL CERTIFICATION

- 10.2.1. 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, inspections, tests and qualification activities detailed in the approved Quality Plan.
- 10.2.2. For pressure containing parts of equipment and main components, PACKAGER/MANUFACTURER shall specify material properties and chemical composition of the materials used in the equipment by means of appropriated certificate.

11 INSPECTION, TESTING AND COMMISSIONING

11.1 INSPECTION

- 11.1.1. PACKAGER/MANUFACTURER shall perform all required inspection and testing in accordance with the referenced documents and technical standards mentioned on section 3, including chapter 14 from NFPA 20. In addition to those, PACKAGER/MANUFACTURER shall comply with the applicable project specifications listed herein, at datasheet and Material Requisition.
- 11.1.2. PACKAGER/MANUFACTURER shall submit the Inspection and Test Plan (ITP) based on the SUPPLIER's technical datasheet with witnessed inspections and tests identified.
- 11.1.3. PACKAGER/MANUFACTURER shall ensure that all the witnessed inspection requirements by the Classification Society are fully accommodated and the due notice requirements are satisfied.
- 11.1.4. If it is found necessary to dismantle any equipment after a test for repair or replacement of components, the test shall be invalidated and repeated.
- 11.1.5. Acceptance of shop tests shall not constitute a waiver of requirements to meet the field tests under specified operating conditions, nor shall inspection relieve MANUFACTURER of his responsibilities in any way whatsoever.
- 11.1.6. The following tests or certificates shall be included in PACKAGER/MANUFACTURER scope:
- Materials of construction of the package Units (vessels, heat exchangers, pumps, diesel engine, etc.) for conformity with the requirements of the specification.
 - Piping, fittings and valves materials and fabrication, which shall conform to specification.
 - Radiographic, dye penetrant, magnetic particles, ultrasonic inspection of welds on the pressure retaining parts of the equipment, and steel structures.
 - Approval of the relief valve settings and witness of their testing after setting.
 - A visual check of the assembly of the PACKAGE, with special notice to:
 - The thickness of the pressure retaining parts meets or exceeds the quoted design thickness.
 - Any repairs.

- Dry-film thickness quoted.
- The general appearances, materials, workmanship and standard of finish are acceptable.
- Dimensional check.
- Alignment to be demonstrated.

11.2 TESTING

11.2.1 PACKAGE FUNCTIONAL TEST

- 11.2.1.1. A full functional test of each completed PACKAGE shall be performed. The satisfactory operation of all indicators, selectors and controllers shall be demonstrated.
- 11.2.1.2. The correct operation of all controllers, alarm and fault protection equipment and indicators shall be demonstrated and, if necessary, fault simulations.
- 11.2.1.3. In addition, following tests shall be included in PACKAGER/MANUFACTURER scope:
- Electrical continuity and insulation checks on all wiring and earthing continuity;
 - Functional checks on all instruments and valves;
 - Control panel tests.

11.2.2 FACTORY ACCEPTANCE TESTING (FAT)

- 11.2.2.1 PACKAGER/MANUFACTURER shall prepare a FAT procedure for the package and submit for BUYER approval.
- 11.2.2.2 FAT procedure shall consider as a reference the test codes mentioned on section 3 of this document.
- 11.2.2.3 PACKAGER shall carry out a Complete Units Test (String Test) on at least one Fire Water Pump PACKAGE from a supplied set.
- 11.2.2.3.1 The String Test shall consist of a 4-hour functional test run at rated operating condition of the entire integrated PACKAGE including all equipment and auxiliary systems within the PACKAGER's scope of supply.
- 11.2.2.3.2 During the String test the following requirements shall be demonstrated:
- a) Start-up time as per NFPA-20.
 - b) Vibrations and temperatures (after thermal stabilization) below alarm levels.
 - c) Pump head, flowrate, and diesel engine output power at rated operating condition, for which the same criteria of the Performance Test shall be applied.
- 11.2.2.4 The MANUFACTURER shall make preliminary test to ensure that all parts of the equipment are operating satisfactorily prior the arrival of PURCHASER's representative.
- 11.2.2.5 PETROBRAS representatives shall witness the FAT.

11.2.2.6 PACKAGER/MANUFACTURER shall invite CLASS surveyor for FAT.

11.2.2.5. The following tests shall be carried out at least:

a) Pumps

a.1) Hydrostatic test

a.2) Performance test (5 points on the curve, including shutoff, minimum continuous stable flow, rated flow and 150% rated flow).

a.3) The hydrostatic and performance tests shall comply with NFPA 20 criteria.

a.4) During performance test, tolerances for rated and 150% flowrate points shall be in accordance with ANSI/HI 14.6 criteria level 1U.

b) Diesel Engine

b.1) Mechanical fit-up and integrity of the drivetrain

b.2) Consecutive starts of each start up system of engine, in accordance with Classification Society Rules.

b.3) Endurance test (for performance data)

e) Safety devices (including Hydraulic Power Pack).

f) Others

f.1) Function of the electrical utility system

f.2) Functional control and control of characteristics of equipment on panel

f.3) Function of HVAC System

f.4) Noise level report

f.5) Consumption of lube oil, cooling water and fuel oil;

11.2.2.7. PACKAGE shall undergo a 4-hour test with the conditions established by the parameters defined on the datasheet. All PACKAGES shall be tested in this condition.

11.2.2.8. PACKAGER/MANUFACTURER shall measure and record vibration and bearing temperature during FAT. Vibration and bearing temperature measurements shall be included on FAT report.

11.2.2.9. Acceptance of the FAT will not be considered as the final acceptance test of the PACKAGES.

11.2.2.10. 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.

11.2.2.11. Acceptance of shop tests shall not constitute a waiver of requirements to meet the field tests under specified operating conditions, nor shall inspection relieve the PACKAGER/MANUFACTURER of his responsibilities in any way whatsoever.

11.2.3 SITE ACCEPTANCE TEST (SAT)

11.2.3.1 PACKAGER/SUPPLIER shall carry out the Site Acceptance Test after complete installation on board the FPSO (including caisson, suction strainer, pipe stacks

and all accessories), and BUYER representatives and CS Surveyor shall witness the following items:

- a) Crank-shaft deflection (cold and hot condition).
- b) Starting of the engine-pump set.
- c) Performance of engine-HPU-pump set (5 points on the curve, including shutoff, minimum recommended flow, rated flow and 150% rated flow).
- d) Start-up in condition of complete loss of electrical supply from platform and loss of CSS controllers.
- e) Test of continuity of operation of the pump in case of turning off the complete electrical power supply from platform and loss of CSS when the pump is running.

11.2.3.2 The SAT Performance Test results shall consider the information of draft and elevation of pressure instruments to build the system's performance curve and verify the Performance tolerance criteria.

11.2.3.3 SAT Performance Test tolerance for rated and 150% flowrate points shall comply with ANSI/HI 14.6 level 2B. The curve used as baseline for this requirement shall be the FAT performance curve.

11.2.3.4 The performance curve, including speed and draft information, shall be recorded, and used as reference for future NFPA-25 performance tests.

11.3 COMMISSIONING

11.3.1. PACKAGER / MANUFACTURER shall provide any necessary support for installation and commissioning of the equipment either at a shore based fabrication yard or on the UNIT, including monitoring systems of the PACKAGE.

11.3.2. SUPPLIER shall provide all consumables necessary to allow commissioning in the environment conditions of the shipyard.


11.3.3. PACKAGER/MANUFACTURER shall demonstrate that the fire water pump shaft and bearing design took into consideration the hydraulic forces during operation away from the duty point anywhere within the range from minimum flow up to the end of performance curve.

12 PREPARATION FOR SHIPMENT

12.1 MARKING

12.1.1. 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 will not damage or impair the component.


12.1.2. Items that cannot be identified shall be rejected. Rejected items may be re-certified by carrying out all relevant testing, with prior approval of the BUYER.

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12.1.3. PACKAGER/MANUFACTURER shall issue during engineering stage the packing list, which shall contain the item number of each part supplied loose in the PACKAGE.

12.2 SHIPMENT PACKING

- 12.2.1. The equipment shall be thoroughly cleaned internally and be free of all loose foreign materials.
- 12.2.2. The equipment shall be supplied tested, flushed and preserved and, if practical, already charged up with coolant and lubricants.
- 12.2.3. The preparation shall make the equipment suitable for 24 months outdoor storage from the time of shipment.
- 12.2.4. The package shall be protected from corrosion.
- 12.2.5. All openings shall be covered or capped to protect the inside from dust, rust and moisture. Dryer shall be enclosed in the package for absorption of moisture.
- 12.2.6. Flanged openings shall be provided with gasketed metal closures securely fastened with bolts or clamps.
- 12.2.7. PACKAGER/MANUFACTURER shall submit the packing design and packing list to the BUYER for approval.
- 12.2.8. PACKAGER/MANUFACTURER shall inform declared weight, rigging plan, package material and type of pesticide used in the package.
- 12.2.9. PACKAGER/MANUFACTURER shall package the equipment in accordance with the packaging requirements of the country to which the equipment is being shipped.
- 12.2.10. PACKAGER/MANUFACTURER shall provide the procedures for unpacking, handling and installation, as well as repacking, and long-term storage requirements.
- 12.2.11. PACKAGER/MANUFACTURER shall specify any limitations applicable to the transport and installation phase.
- 12.2.12. The equipment shall be securely packed for shipment from PACKAGER/MANUFACTURER location to the actual equipment destination. All items shall be protected from handling damage either by protective packing with cartons, crates, etc. or by securing to pallets. All material shall be packed in a way that handling with forklift truck or crane is possible.
- 12.2.13. 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.

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12.2.14. If there is a risk of damage to valves and other appurtenances during transportation, they shall be disconnected and tagged. All components shall then be securely packed as above.

12.2.15. Spare parts and tools to be packed separately and clearly marked "Spare Parts" and "Tools" respectively.

12.2.16. Each package shall be clearly marked with its gross weight, to enable safe handling.

12.2.17. The packing list shall clearly show:

- Vessel name
- BUYER's order number;
- BUYER's item number;
- Partial or complete delivery for each order number;
- Description;
- Number of packages;
- Gross weight of each package.

12.2.18. The rust preventatives list shall give instructions for removal of preventatives where required, and necessary procedures to be imposed during storage.

12.2.19. All unpainted carbon steel pressure vessels and piping shall be protected internally with corrosion inhibitor prior to shipment. If necessary, PACKAGER/MANUFACTURER shall provide instructions to remove the corrosion inhibitor prior to the commissioning.

12.2.20. Vulnerable instruments shall be removed and separately packed for shipment.


12.2.21. Transportation bracing/ support shall be used where necessary and shall be clearly identified as temporary.

12.2.22. PACKAGER/MANUFACTURER shall provide a Delivery Specification, which shall describe all loose items furnished in a completely or not completely assembled condition. Delivery Specification shall clearly indicate BUYER's order number in the headlines and item number for each loose item shipped by the PACKAGER/MANUFACTURER.

13 ASSEMBLY ASSISTANCE AND COMMISSIONING REQUIREMENTS

13.1. PACKAGER/MANUFACTURER is responsible for assembly supervision of the equipment, including the assembly of components to be delivery loose (for example, lift pumps and pipe stacks).

13.2. PACKAGER/MANUFACTURER shall provide preservation procedures for FIRE WATER PUMPING UNITS installed on its final location during shipyard construction phase.

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13.3. PACKAGER/MANUFACTURER is responsible for pre-commissioning and commissioning supervision of the equipment/system. Final acceptance shall be on satisfactory completion of commissioning tests as specified by BUYER.

14 PACKAGER/MANUFACTURER RESPONSIBILITY

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

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

14.3. PACKAGER/MANUFACTURER's responsibility shall also include but not limited to:

- Resolving all engineering questions and/or problems relating to design and manufacture.
- Providing details as requested of Sub-Suppliers relating to design and manufacturing.
- Installation at site by others, however, presence of supervision shall be required for all installation and commissioning activities which PACKAGER/MANUFACTURER indicates as necessary. PACKAGER/MANUFACTURER shall define those activities, which shall be approved by BUYER.
- PACKAGER/MANUFACTURER's responsibility shall also include Commissioning & Training for operation.

14.4. 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.

15 REQUIRED DOCUMENTATION

15.1. PACKAGER / MANUFACTURER shall provide original documents in PDF format for all required documents. Extracted figures from catalogue or manual, especially for the outline drawings of components such as couplings, mechanical seals and auxiliary equipment will not be accepted. Whenever required by BUYER, source files shall also be provided.

15.2. All documents required in this section shall be text searchable, including PDF files.

15.3. Before any document is issued by PACKAGER/MANUFACTURER, a document list shall be issued and approved by BUYER. This is required in order to guarantee the correct document numbering.

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

- General arrangement drawing;
- Cross section drawing;

- Datasheet;
- Performance curves, including Head, Power, efficiency and required NPSH versus flow rate.

15.5. 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: UB-5420501A – Diesel-Hydraulic Fire Water Pumping Unit “A” – Piping and Instrument Diagram (Unit “A”).

15.6. If PACKAGER / MANUFACTURER issues documents which contain information valid for more than one pump tag, pump tag and service description shall be omitted and replaced by “Diesel-Hydraulic Fire Water Pumping Units”:


EXAMPLE: “Diesel-Hydraulic Fire Water Pumping Units”– Inspection and Test Plan.

15.7. The following documents shall be issued and approved before FAT execution. Otherwise, BUYER will not attend the FAT and will not accept its execution:

- Piping and instrumentation diagram;
- General arrangement drawing;
- Cross section drawing with part list;
- Main and auxiliary equipment datasheets;
- Weight and center of gravity datasheet;
- Noise datasheet;
- Performance curves;
- Utility consumption list and heat dissipation;
- Inspection and Test Plan (ITP), including auxiliary equipment;
- Hydrostatic test procedure;
- Painting and insulation specification;
- Torsional analysis report;
- Fatigue analysis report for pipe stack top support, considering normal operation and transient events;
- Air release valves calculation report;
- FAT procedure.

15.8. The following documents shall be issued and approved before delivery of the PACKAGE. Otherwise, BUYER will not attend to the receiving inspection, and will not accept the PACKAGE:

- Nameplate drawings;
- Noise report;
- FAT report;
- Handling drawing for installation;
- Installation manual;
- Instruments and instrumented valves Datasheets;
- Packing list;

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15.9. The following documents shall be issued and approved before issuance of the Databook. Otherwise, BUYER will not accept the Databook:

- Mechanical seal drawing;
- Coupling drawing;
- Outline drawings of auxiliary equipment;
- Operation and maintenance manuals for main and auxiliary equipment;
- List of spare parts for commissioning and start up;
- List of recommended spare parts for two years of operation;
- List of special tools;
- List of instruments and instrumented valves;
- List of set points, alarms and shutdown;
- Logic diagrams;
- Cause and effect charts;
- Loop diagram
- Electromechanical panel drawing;
- Memory maps;
- Automation architecture;
- Interconnection wiring diagram;
- Calculation notes of control valves, PSVs and flowmeters;
- I/O List;
- HMI screen layout;
- Calibration certificates of instruments;
- Fabrication procedures of pressure vessels classified in NR-13;
- NDT procedures of pressure vessels classified in NR-13;
- Hydrotest reports for pressure vessels classified in NR-13;
- Hydrotest report of pumps;
- NDT reports;
- Material certificates;
- Heat treatment records;
- Databook index.


15.10. All documents for Fire Fighting and Fire Detection System shall follow requirements of I-ET-3010.00-5420-300-P4X-001 - Fire Protection for Machinery Hoods and I-ET-3010.00-5425-260-P4X-002 - IG-541 FIXED FIREFIGHTING TOTAL FLOODING SYSTEM.

15.11. All documents for electric motors shall be according to I-ET-3010.00-5140-712-P4X-001 – Low-Voltage Induction Motors for Offshore Units.

15.12. PACKAGER/MANUFACTURER shall identify and include location of all water mist or clean agent flooding fire fighting system sensors and nozzles on general arrangement drawing of the PACKAGE or in a separate drawing.

15.13. Installation, operation and maintenance manuals shall be issued in Portuguese. PACKAGER / MANUFACTURER may choose to issue one single manual with installation, operation and maintenance instructions.

15.14. Installation manual shall contain all recommendations for preservation during storage on erection stage and long-term storage. If PACKAGER / MANUFACTURER fails to provide this information on the installation manual, any

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damages due to the lack of preservation shall be PACKAGER / MANUFACTURER's responsibility.

- 15.15. Installation manual shall contain a list of all consumables to be used for erection, commissioning and start up.
- 15.16. Maintenance manual shall contain the specification of lubricant fluids and periodicity of replacement.
- 15.17. Maintenance manual shall contain instructions to assemble and disassemble each major piece of the equipment, such as mechanical seal, rotor and roller bearings. This information may be provided on a separate manual for the piece as well.
- 15.18. PACKAGER / MANUFACTURER may choose to include specific commissioning instructions on the operation manual, or to issue a separate document, such as a procedure, for commissioning instructions.
- 15.19. Operation manual shall contain, among other information, the control system description of the PACKAGE.
- 15.20. General arrangement drawings shall contain the connection list, i.e., a list with all connection tie-in points of the skids, which shall have the following minimum information: Connection identification number (which shall be represented in the drawing), connection description, tie-in connection specification, that is, rating, manufacturing standard, flange face type, connection nominal diameter and fluid.
- 15.21. Mechanical seal drawings shall contain a list with all connections on the seal, including identification code (which shall be represented on the mechanical seal drawing), connection description and fluid. Mechanical seal drawings shall contain also a part list with identification number of the part, description of the part and material of each part. Identification number of seal parts shall be different from the identification code of the connections. For example, identification codes can be letters and parts identified by numbers.
- 15.22. PACKAGER / MANUFACTURER shall inform either in the Datasheet or in the performance curve the flow rates defining the preferred operation region and the allowable operation region of the equipment.
- 15.23. Each material certificate and NDT report provided shall be preceded by a PACKAGER / MANUFACTURER sheet, informing to which part of the equipment the document refers.
- 15.24. PACKAGER/MANUFACTURER shall issue drawings and diagrams using the symbols defined on I-ET-3000.00-0000-940-P4X-002 – SYMBOLS FOR PRODUCTION UNITS DESIGN.
- 15.25. PACKAGER/MANUFACTURER shall include manual of ancillary equipment on section II of Databook.
- 15.26. All inspections, NDTs and tests predicted by PACKAGER in the Inspection and Test Plan shall have a report, which shall be included in the Databook.