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	CLIENT: SRGE	SHEET: 1 of 24
	JOB: REFERENCE BASIC DESIGN	1001056398 0010
	AREA: BÚZIOS	
DP&T-SRGE	TITLE: <b>DIESEL - HYDRAULIC FIRE WATER PUMPING UNIT</b>	NP-1 ESUP

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DATE	JAN/21/19								
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EXECUTION	ERNANI								
CHECK	KALINO								
APPROVAL	TMCAMPOS								

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## 1 INTRODUCTION

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 3 (three) Diesel-Hydraulic Fire Water Pumping Unit – UB-5420501A/C described below, that shall operate on Reference Basic Design Unit, at Búzios Field Development, offshore Brazil. The units shall be supplied as complete, self-contained, skid-mounted packages, installed in dedicated fire rated enclosures (containers).

## 2 NORMATIVE REFERENCES

The equipment shall comply with the requirements of this technical specification, data sheets, documents as stated below and with those referred to herein.

### 2.1 CLASSIFICATION

CONTRACTOR shall perform the work in accordance with the requirements of Classification Society.

Certification and approval as required by CS Rules is CONTRACTOR's responsibility. CONTRACTOR shall obtain approval for all parts of their work as required by CS before shipment of the equipment to the shipyard.

### 2.2 CODES AND STANDARDS

The latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used, provided it can be shown that they meet or exceed the requirements of the standards referenced below:

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;
ASME/ANSI B 73.1	Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process;
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;
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests;
ASME/BPVC Sec.VIII	Rules for Construction of Pressure Vessels;
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;
ISO 3046/ all parts	Reciprocating Internal Combustion engines;

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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;

**2.3 GOVERNMENTAL REGULATION**

Brazilian Ministry of Labor (*Ministério do Trabalho e Emprego*):

NR 10	<i>Segurança em Instalações e Serviços em Eletricidade</i> (Safety in Electrical Facilities and Services);
NR 13	<i>Caldeiras, Vasos de Pressão, Tubulações e Tanques Metálicos de Armazenamento</i> (Boilers, Pressure Vessels, Piping and Metallic Storage Tanks);
NR 26	<i>Sinalização de Segurança</i> (Safety Signalling);
NR 30	<i>Segurança e Saúde no Trabalho Aquaviário – Anexo 2</i> (Safety and Health in Waterway Labor – Annex 2)
NR 37	<i>Segurança e Saúde em Plataformas de Petróleo</i> (Safety and Health in Oil Platforms);

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

**2.4 PETROBRAS DOCUMENTS****• Safety / Process**

I-FD-3010.1M-5420-319-P4X-001	Diesel Hydraulic Fire Water Pumping Unit
I-RL-3010.1M-1200-940-P4X-001	General Specification for Available Utilities
I-DE-3010.1M-5423-944-P4X-001	Piping and Instrument Diagram - Fire Water Pump Set (Diesel Hydraulic Unit "A")
I-DE-3010.1M-5423-944-P4X-002	Piping and Instrument Diagram - Fire Water Pump Set (Diesel Hydraulic Unit "B")
I-DE-3010.1M-5423-944-P4X-003	Piping and Instrument Diagram - Fire Water Pump Set (Diesel Hydraulic Unit "C")
I-DE-3010.1M-5400-94A-P4X-001	Area Classification - General
I-ET-3010.00-5420-300-P4X-001	Fire Protection for Machinery Hoods
I-ET-3010.00-5400-947-P4X-002	Safety Signalling


**• Mechanical**

I-ET-3010.00-1200-251-P4X-001	Bolt Materials
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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
I-ET-3010.00-1200-540-P4X-002	Requirements for Pressure Vessel Fabrication
I-ET-3010.00-1200-955-P4X-001	Welding
I-ET-3010.00-1200-955-P4X-002	Requirements for Welding Inspection
I-ET-3010.00-1200-956-P4X-002	General Painting
I-ET-3010.1M-1200-200-P4X-002	Piping Specification for Hull
I-ET-3010.1M-1200-300-P4X-002	Noise Control for Requirements Accommodation /Hul
DR-ENGP-I-1.15-R.3	Color Coding
• <b>Electrical</b>	
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-3010.1M-5265-946-P4X-002	Hull UPS and DC Systems One-Line Diagram
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-3010.00-5140-797-P4X-001	Electrical System Automation Architecture
• <b>Automation</b>	
I-ET-3010.00-1200-800-P4X-002	Automation, Control and Instrumentation on Packaged Units
I-ET-3010.1M-1200-800-P4X-014	Automation Interface of Packaged Units
• <b>Arrangement</b>	
I-DE-3010.1M-1200-942-P4X-002	General Arrangement
• <b>Naval</b>	
I-RL-3010.1M-1350-960-P4X-009	Motion Analysis
• <b>General</b>	
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-3A36.00-1000-941-PPC-001-revD	Metoccean Data

## 2.5 CONFLICTING REQUIREMENTS

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

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### 3 DEFINITIONS AND ABBREVIATIONS

#### 3.1 DEFINITIONS

- “May”: permissible within the limits of the standard (a permission).
- “Shall”: must be followed strictly in order to conform to the standard.
- CONTRACTOR: The Supplier, Manufacturer or Contractor of the goods and/or services described in the Equipment/Material Specifications and designated as such in the contract or purchase order.
- PURCHASER: The Company designated as such in the contract or the purchase order.
- Field proven: Field proven equipment is defined by PETROBRAS as having a reference list with at least 3 (three) operating equipment supplied by CONTRACTOR, of similar capacity, installed in offshore production units.

#### 3.2 ABBREVIATIONS

- CCR: Central Control Room  
CS: Classification Society  
CSS: Control and Safety System  
F&G: Fire and Gas  
FGS: Fire and Gas System  
FPSO: Floating, Production, Storage and Offloading (vessel)  
NPSH: Net Positive Suction Head  
UAM: Unit Alarm Malfunction

### 4 GENERAL TECHNICAL REQUIREMENTS

#### 4.1 OPERATION ENVIRONMENT/ MOTION REQUIREMENTS

The equipment supplied shall be suitable for the environment and range of ambient condition including wind and motions as defined in I-ET-3A36.00-1000-941-PPC-001\_revD.

The necessary design data and information on motion requirements are given in I-RL-3010.1M-1350-960-P4X-009 - Motion Analysis.

The equipment shall be able to operate under inclination (static and dynamic) as specified by the CS requirements.:

- Heel/roll: 22.5° static/dynamic
  - Trim/pitch: 10° static/dynamic
- These conditions may occur simultaneously.

#### 4.2 DESIGN CONDITIONS

CONTRACTOR shall design the package for the full range of operational conditions as specified in I-FD-3010.1M-5420-319-P4X-001 - Diesel Hydraulic Fire Water Pumping Unit.

#### 4.3 EQUIPMENT LOCATION

The Diesel-Hydraulic Fire Water Pumping Units will be installed on board as follows:

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 upper deck at port side and starboard side as shown in the I-DE-3010.1M-1200-942-P4X-002 – General Arrangement.

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

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

Enclosure HVAC system shall be provided by CONTRACTOR in compliance with item 5.7.1 to meet normal operation (diesel engine in stand-by) and firefighting operation condition (diesel engine running).

Container shall include an emergency door or emergency trapdoor.

#### 4.4 DESIGN REQUIREMENT

It is CONTRACTOR's responsibility to submit to the CS the documentation in compliance with Rules in force.

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

In addition, each one of those packages shall present:

- a) availability over 98%;
- b) historical record according to Table 4-1:

Table 4-1 Minimum amount of operation hours recorded for Mechanical Equipment

Rated Power	Operation Hours
Up To 200 HP	8,000
Between 201 And 600 HP	12,000
Between 601 And 1200 HP	16,000
Over 1200 HP	24,000

Deviations from the items above, related to the "field proven design" may be accepted only for equipment which is part of research or development programs. In this case, their use shall be formally approved by PETROBRAS.


The design of both Lift Pump and Booster Pump shall comply with standards and reference documents of the item 2, specially the requirements of NFPA 20.

The shaft sealing system shall be in accordance with API 682 Standard with mechanical seals of cartridge type.

Pumps shall be designed with maximum suction specific speed (N<sub>ss</sub> – Suction specific speed) of 10,000 (US unit).

Rated flow plus the required cooling water for diesel engine shall be within the region of 80% up to 120% % of best efficiency point flow.

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.

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Material selection for lift pumps and booster pumps shall be according to API 610 Table H Class D2 or Bronze Nickel Aluminium alloy.

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 superduplex material is specified. Anti-corrosion systems are not required if pumps of Bronze Nickel Aluminium alloy are specified.

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.

#### 4.5 DESIGN LIFETIME

Equipment shall be designed for a 25 year life in a corrosive offshore environment without the need for replacement of any major component due to weather, corrosion, fatigue or material failure.

CONTRACTOR is requested to consider a continuous running without stop to maintenance at least of 12 (twelve) months and in case of intermittent service at least of 18 (eighteen) months.

#### 4.6 NOISE

This item establishes the minimum requirements for noise control to be observed and describes the basic procedures for the measurement and reporting of airborne sound levels of equipment.

Noise control analysis is a mandatory item to be carried-out and shall comply with requirements of I-ET-3010.1M-1200-300-P4X-002 – Noise Control Requirements for Accommodation/Hull.

#### 4.7 SUBCONTRACTOR

Additionally CONTRACTOR shall be responsible for all co-ordination with subcontractors and collections of all details, drawings and data to achieve optimum design and full submission of all documents requested in the specification.

CONTRACTOR shall list their tender the respective subcontractor for the following major items:

- Driver
- Gearbox (if applicable)
- Coupling
- Pumps
- Pump seals
- Hydraulic Power Pack
- Enclosure

### 5 EQUIPMENT SPECIFICATION

The Fire Water Pumping Units shall be supplied as complete, self-contained, skid-mounted packages, installed as mentioned in the item 4.2 Equipment Location.





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Units 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 Units.

Units shall be able to start and reach the rated operation load, independent of any external power supply.

The fire water pumping system shall be provided with sea water supplied by 3 (three) fire water pump units driven by diesel engine as follows:

- Diesel-Hydraulic Fire Water Pump Unit UB-5420501A
- Diesel-Hydraulic Fire Water Pump Unit UB-5420501B
- Diesel-Hydraulic Fire Water Pump Unit UB-5420501C

The Diesel Hydraulic Fire Water Pumping Unit 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.

The Centrifugal Lift Pump of UB-5420501A/C units shall be installed submerged inside of steel caissons, fitted in hull side at Port and Starboard in the Upper Deck stern. The steel caissons will be lengthened until the vessel base line.

Requirements of NR 13 Brazilian Regulation “*Caldeiras, Vasos de Pressão, Tubulações e Tanques Metálicos de Armazenamento*” shall be applied.

The Units with all equipment, piping, valves, wiring, instruments and fittings shall be supplied complete, approved by CS and ready for erection on board.

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 or PVC.

The packaged shall be supplied with the followings as specified below.

## 5.1 FIRE WATER PUMPS

The fire water pumps shall be selected according to requirements outlined in NPFA 20 and requirements of I-FD-3010.1M-5420-319-P4X-001 Diesel-Hydraulic Fire Water Pumping Unit.

A mechanical seal with a throttling bushing shall be selected complying with API 682.

Material selection for lift pumps and booster pumps shall be according to API 610 Table H Class D2 or Bronze Nickel Aluminium alloy.

The Centrifugal Lift Pump of Diesel-Hydraulic Fire Water Pumping Units UB-5420501A/C, shall be installed submerged inside of steel caisson comprising of:

- 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



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The Centrifugal Lift Pump shall be kept in continuous running at low speed when in stand-by.

Lift Pump shaft seal shall prevent leakage of hydraulic oil to sea water and vice-versa.

The booster pump shall be directly coupled to the diesel engine via a flexible coupling. The pump shall be mounted on the same skid as the engine, hydraulic oil tank, hydraulic pump, controller, distribution panel, etc. The booster pump shall be designed to withstand dry running for shorter periods. The pump shall have a 20% margin between any operating speed and the critical speed. Unit shall have rigid shaft, operating below the first critical speed. Suppliers are 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.

Pumps operating in parallel shall have a 10% difference between the shut-off head and the operation point.

The NPSH required shall be at least 2m less than the NPSH available. Correction factors are not allowed. PURCHASER may accept differences between 1m and 2m, but a witnessed NPSH test shall be performed.

Surge drums equipped with pressure and vacuum relief valves shall be supplied to be installed on the discharge of each booster pump.

CONTRACTOR 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.

## 5.2 TRANSMISSION

Speed changing transmission may be used when the optimum speed desired differs from the driver speed and the application is economically justifiable and approved by the PURCHASER. In this case, gear units as per API 677 are mandatory.

## 5.3 COUPLING AND GUARDS

Coupling shall be provided between the firewater pump and the diesel driver in compliance with the requirements of API 671.

Flexible coupling shall be used for flange-mounted drives.

Spacer of adequate length shall be provided to allow removal of coupling hub and driven equipment.

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

## 5.4 HYDRAULIC POWER PACK

The Hydraulic Power Pack, located inside the container, shall be directly driven by the diesel engine.

The minimum cleanliness requirements of the fluid in the hydraulic power system shall be NAS 7 class.

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 Unit's manufacturer.

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).

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.

The required hydraulic oil temperature shall be kept by cooler supplied together with the hydraulic unit.

The hydraulic power pack shall be supplied with the followings items specified below:

#### **5.4.1 Hydraulic Pump**

The hydraulic power pack shall be provide 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 (if applicable).

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.

#### **5.4.2 Hydraulic Oil Heat Exchangers**

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

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

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

Pressure relief shall be provided for protection against overpressure.

#### **5.4.3 Hydraulic Oil Piping**

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

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

#### **5.4.4 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 sigh glass
- e) Drain with self-closing valve

#### **5.4.5 Strainer**

Continuous flow dual type with replaceable filtering elements with back flush valves shall be provided. The filter system shall be able to operate offline.

## 5.5 DIESEL ENGINE

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.

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.

The coupling between the diesel engines and the pumps shall be a flexible coupling mounted directly on the crankshaft.

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 will be fitted to detect reverse rotation.

The diesel engines will run with Marine Diesel Oil.

The diesel engine power (kW) ratings, curves and performance data shall be furnished by CONTRACTOR to PURCHASER collated in the bid.

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 comply with MARPOL annex VI.

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). Batteries, combined, shall be sized, based on calculations, to have capacity to carry the loads defined in 11.2.7.2.3 of 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
  - Positive displacement mechanical injection pump driven by diesel engine shaft, with injection nozzles for the various cylinders;
  - Oil main gears pump driven by engine shaft;
  - Manual priming pump for emergency use;
  - Flexible fuel lines
  - Flexible connection with fire-protection, built of AISI 316L stainless steel;
  - Dual filter with throwaway elements, with valves for reversing flow, continuous flow type;
  - Duplex type fuel filters, with insert replaceable without interrupting the fuel supply to the engine;
  - Water/oil separator filter.
- 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.
- 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.
  - 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 shall be accomplished using a heat exchanger, which shall be fed from the firewater pumps discharge line.
  - 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 arrester;
  - Exhaust system shall be sized in such a manner as to avoid engine performance being jeopardized by backpressure;
  - 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.
- Combustion Air System
- Others
  - Coupling and Turning gear;
  - Speed governor (electronic allowed but not required).
  - Resilient Mounts for diesel engine shall be designed to withstand static loads as well as dynamic loads arising from FPSO motions.
  - 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 will be acceptable;
  - 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

Supply scope shall include block and stop valves upstream and downstream the cylinder, pressure control valve, safety valve for each cylinder, pneumatic drive unit, air filter, lubricating unit and all piping to connect the cylinder with the motor, in addition to the piping upstream to the cylinder, up to the skid limit.

VENDOR shall supply the atmospheric emissions report (on demand) referencing applicable regulatory rules.

## 5.6 INSTRUMENTATION

For automation type classification CONTRACTOR shall refer to I-ET-3010.1M-1200-800-P4X-014 (Automation Interface of Packaged Units). The package shall comply with I-ET-3010.00-1200-800-P4X-002 (Automation, Control and Instrumentation on Packaged Units).

### 5.6.1 Control Panels

The unit control panel shall be built according to a recognized Classification society and relevant NFPA-20 regulations.

The fire water pumping unit will be started:

- Automatically by pressure drop in the firewater header with time delay (CONTRACTOR 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.

The fire water pumping unit shall be stopped:

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

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

- Confirmation of combustible gas at the Unit's room ventilation air intake,
- Confirmation of combustible gas at the combustion air intake
- Confirmation of fire inside the containerized pump room

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).



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

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

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

For a list of signals exchanged between diesel-hydraulic fire water pumping unit and the automation systems, consult I-ET-3010.1M-1200-800-P4X-014 AUTOMATION INTERFACE OF PACKAGED UNITS.

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

## 5.7 ENCLOSURE

Each Diesel-Hydraulic Fire Water Pumping Units UB-5420501A/C package shall be mounted in a complete fire rated enclosure.

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.

The enclosure shall comply with the item 4.6 of this specification.

### 5.7.1 HVAC System

CONTRACTOR 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 in 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 of I-ET-3010.1M-1200-800-P4X-014 - 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 from 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.

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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.

### 5.7.2 Fire Fighting and F&G Detection System

A F&G detection system, as well as, a firefighting system shall be foreseen for each Fire Water Pumping Unit – UB-5420501A/C.

The firefighting system shall be supplied complete by CONTRACTOR, comprising firefighting medium, piping, valves, fittings and CO2 diffusers.

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.

Fire Fighting and Fire Detection System specification shall follow requirements of I-ET-3010.00-5420-300-P4X-001 - Fire Protection for Machinery Hoods.

### 5.7.3 Maintenance Lifting Beam

All necessary maintenance lift beams shall be provided to facilitate safe and easy maintenance. All lifting beams (if required) shall overhang by at least 1 m.

## 5.8 SKIDS

CONTRACTOR shall design and construct a steel structural skid to accommodate equipment within CONTRACTOR'S scope of supply.

The skid shall be of a rigid construction and self-supporting, which will not distort during hoisting, operation and shipment.

When lifting the skids, complete with all equipment mounted, beam deflection shall not exceed 1/400 L.

The skid shall be designed:

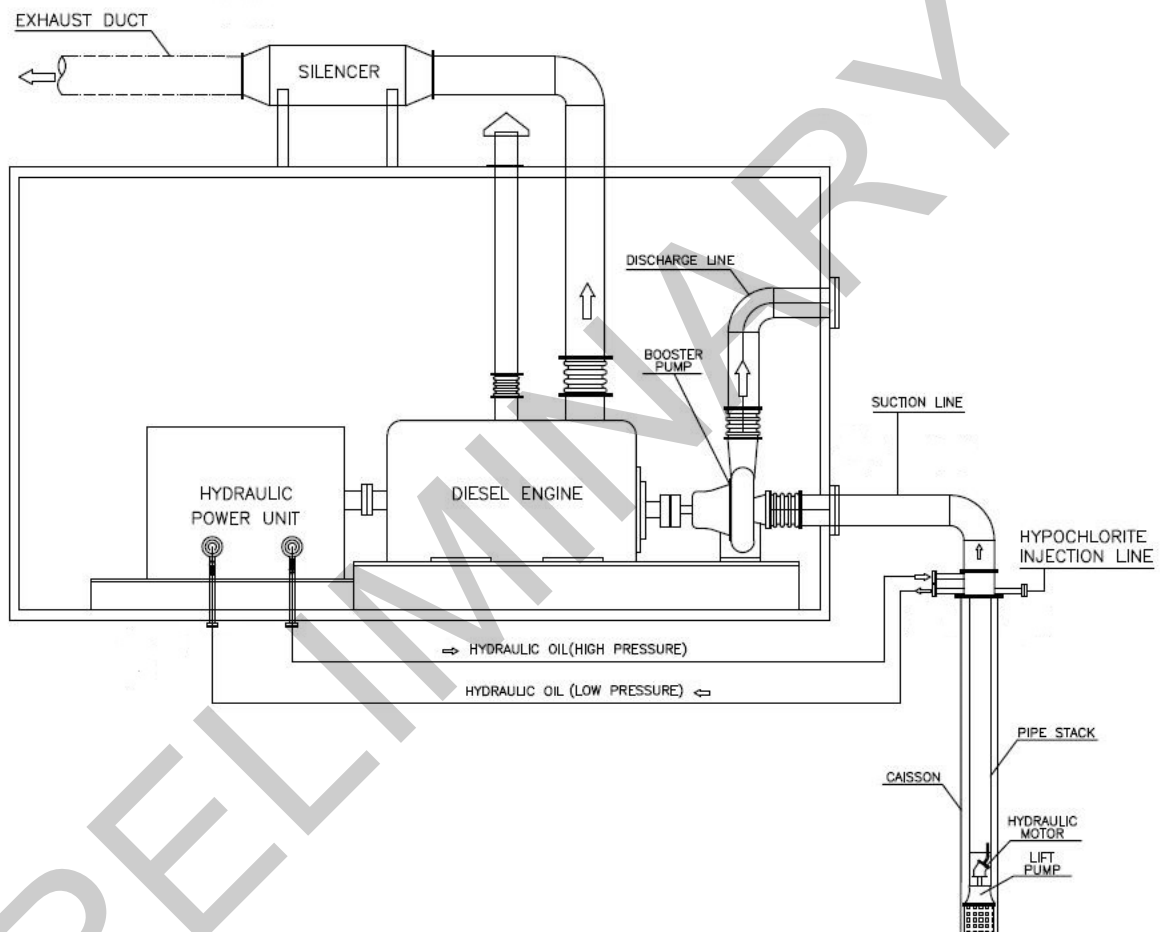
- To resist all sling forces, including both horizontal and vertical components of the applied sling angle (sling angles shall be within between 50 and 90 degrees with the horizontal plane).
- With lifting facilities to permit the entire package to be lifted by crane as a single point lift for transportation and installation.
- So that it is self-draining and after installation, fluid shall not collect 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.



## 5.9 PRESSURE VESSELS

All pressure vessels shall comply with the requirements of NR 13 – Brazilian Labour Ministry Rules and comply with requirements of I-ET-3010.00-1200-540-P4X-001/002 - Requirements for Pressure Vessels Design/Fabrication.

## 5.10 UNIT SKETCH



## 6 PAINTING

Paint System for external coating must comply with requirements of I-ET-3010.00-1200-956-P4X-002 – General Painting.


Color code adopted shall be in accordance DR-ENGP-I-1.15 – Color Coding

## 7 ELECTRICAL REQUIREMENTS

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)

All electrical equipment and design shall fully comply with document I-ET-3010.00-5140-700-P4X-002 (Specification for Electrical Material and Equipment for Offshore Units) and

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I-ET-3010.00-5140-700-P4X-003 (Electrical Requirements for Packages for Offshore Units).

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

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.

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

## 8 SAFETY REQUIREMENTS

Personnel safety protection shall be provided according to Regulatory Standards by Brazilian Ministry of Labour.

Warning signs in Brazilian Portuguese language shall be provided where risk of personnel injury exist.

Safety Signalling shall be in full compliance with I-ET-3010.00-5400-947-P4X-002 Safety Signalling.

## 9 NAMEPLATES

CONTRACTOR shall attach a corrosion resistant nameplate on each item of equipment and in an accessible location, fastened with corrosion resistance pins.

The name plate information shall include, as a minimum, the following in the brazilian portuguese language:

- Purchase order and item number;
- Manufacturer and year of production;
- Driver and ancillary equipment's serial number and type;
- Capacity, head, volume, etc;
- Driver power rating and speed, etc;
- Design code;
- Design temperature and pressure;
- Operating temperature and pressure.
- Tag.

All technical data on the nameplates shall be shown in metric units, except for pressure which shall be indicated in 'bar'.

## 10 TAG NUMBERING

Tagging of all items including valves shall be carried out in accordance with I-ET-3000.00-1200-940-P4X-001 - Tagging Procedure for Production Units Design and I-ET-3010.00-5140-700-P4X-001 - Specification for Electrical Design for Offshore Units.

The following main item tag numbers listed in Table 10-1 is indicative but not exhaustive.



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Table 10-1 – Main Package Equipment TAGs

UB-5420501A/C	Diesel-Hydraulic Fire Water Pumping Unit
B-UB-5420501A/C-01	Fire Water Lift Pump
B-UB-5420501A/C-02	Fire Water Booster Pump
MC-UB-5420501A/C	Diesel Engine For Fire Water Pumping Unit
UH-UB-5420501A/C	Hydraulic Unit For Diesel-Hydraulic Fire Water Pumping Unit
BT-UB-5420501A/C-01A/B	Fire Water Pump 24Vdc Starting Battery
BT-UB-5420501A/C-02	Fire Water Pump 24Vdc Control Battery
CB-UB-5420501A/C-01A/B	Battery Charger 24 VDC For Fire Water Pumping
CB-UB-5420501A/C-02	Fire Water Pump 24Vdc Control Battery-Charger
CN-UB-5420501A/C	Fire Water Pumps Room CO <sub>2</sub> Battery
PN-UB-5420501A/C	FWPU Power and Control Panel
TQ-UB-5420501A/C	FWPU Diesel Daily Tank
To be tagged later	Set of handling devices (inside the container)

Tags shall be supplied with number and description in the brazilian portuguese language.

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

Valves shall be tagged with the applicable number only.

Tag numbers for remaining ancillary shall be given after P.O. placement.

## 11 SPARE PARTS

CONTRACTOR 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.

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


## 12 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.

## 13 INSPECTION AND TESTING

### 13.1 INSPECTION

CONTRACTOR and their subcontractor(s) shall perform all required inspection and testing in accordance with the referenced design code and/or applicable industry standards. In addition to industry codes and CONTRACTOR standards, CONTRACTOR and their subcontractor(s) shall comply with the applicable project specifications listed herein.

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CONTRACTOR shall submit the Inspection and Test Plan (ITP) and Quality Plan based on the technical data sheet with witnessed inspections and tests identified.

CONTRACTOR shall provide document schedules with the appropriate completion dates at the time drawings will be submitted for approval as indicated in the agreed document schedule.

PETROBRAS reserves the right to inspect the package at any time during fabrication to ensure that the material and workmanship are in accordance with this specification.

CONTRACTOR shall be responsible for compliance certificate carrying out all work examinations and test under surveillance of CS and shall be financially responsible for final inspection and testing.

The inspector shall have the right to request inspections or examinations to ensure that the equipment complies with the relevant CS requirements. In case examination reveals deviations and/or shortcomings CONTRACTOR shall bear the full cost of such inspection and replacement where necessary. Any repair shall first be approved by the PURCHASER. The subsequent examination necessary to ensure the satisfactory manufacture of the equipment in question will be at CONTRACTOR cost.

Except as approved by the PURCHASER's inspector, all equipment shall be presented for inspection in an unpainted state. CONTRACTOR shall provide at least two weeks notice to the inspector to witness the specified tests.

## 13.2 TESTING

### 13.2.1 PACKAGE FUNCTION TEST

Unless waived by PETROBRAS the following inspections and checks shall be witnessed by PETROBRAS inspector:

- Verification of materials of construction of the package units (vessels, heat exchangers, pumps, diesel engine, etc.) for conformity with the requirements of the specification.
- Verification that piping, fittings and valves conform to specification of materials and fabrication.
- 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.
- Review of I.T.R's.
- A visual check of the assemblies package noting:
  - That 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, etc.
  - Alignment to be demonstrated.

### 13.2.2 FACTORY ACCEPTANCE TESTING (FAT)

CONTRACTOR shall prepare a factory acceptance test / procedure (FAT) for the package and submit for PURCHASER approval.

For the Factory Acceptance Test (FAT), the CONTRACTOR shall make preliminary test to ensure that all parts of the equipment are operating satisfactory prior to the arrival of the PURCHASER's representative.

The FAT will be witnessed by PURCHASER representatives. CONTRACTOR shall advise the PURCHASER of the test schedule before the planned test dates. CONTRACTOR shall invite CLASS surveyor for FAT.

The following tests shall be carried out at least:

- Pumps
  - Hydrostatic test
  - Performance test (5 points on the curve, including shutoff, minimum, rated and 150% rated flow)

The hydrostatic and performance tests shall comply with NFPA 20 criteria. During performance test, tolerances for rated point shall be in accordance with ANSI/HI 14.6 criteria level 1U considering a rated head tolerance of (0, +6%) for lift pumps, booster pumps and lift and booster pumps series assembly.

- Diesel Engine
  - Mechanical fit-up and integrity of the drive train
  - Crank-shaft deflection ( cold and hot condition )
  - Starting test of engine
  - Endurance test ( for performance data )
- Safety devices ( inclusive Hydraulic Power Pack )
  - Consumption of lube oil, cooling water and fuel oi;
  - Measurement of mechanical oscillations (vibrations)
- Others
  - Function of the electrical utility system
  - Functional control and control of characteristics of equipment on panel
  - Function of HVAC System
  - Noise level report

Acceptance of the FAT will not be considered as the final acceptance test of the package unit.

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.

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 CONTRACTOR of his responsibilities in any way whatsoever.

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**13.2.3 SITE ACCEPTANCE TEST (SAT)**

The test shall be carried out after installation on board the FPSO and the following items shall be carried out with witness by PURCHASER representatives and CS Surveyor:

- Crank-shaft deflection ( cold and hot condition )
- Starting of the motor-pump set
- Performance of motor-pump set (5 points on the curve, including shutoff, minimum, rated and 150% rated flow). The performance curve shall be registered as a reference for future NFPA 25 performance tests.
- 48 (forty-eight) hours of continuous running on rated flow

**14 PREPARATION FOR SHIPMENT****14.1 MARKING**

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.

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 PURCHASER.

As a minimum, the following identification shall be provided:

- Project Number
- Manufacturer's name
- Purchase Order Number
- Minimum Breaking Load (MBL)
- Item Number
- Classification Society surveyor's stamp

**14.2 SHIPMENT PACKING**

The equipment shall be thoroughly cleaned internally and be free of all loose foreign materials.

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

The preparation shall make the equipment suitable for 12 months outdoor storage from the time of shipment.


The package shall be protected from corrosion.

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.

Flanged openings shall be provided with gasketed metal closures securely fastened with bolts or clamps.

CONTRACTOR shall submit the packing design and packing list to the PURCHASER for approval.

CONTRACTOR shall inform declared weight, rigging plan, package material and type of pesticide used in the package.

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CONTRACTOR shall package the equipment in accordance with the packaging requirements of the country to which the equipment is being shipped.

CONTRACTOR shall provide the procedures for unpacking, handling and installation, as well as repacking, and long-term storage requirements.

CONTRACTOR shall specify any limitations applicable to the transport and installation phase.

The equipment shall be securely packed for shipment from CONTRACTORs location to the actual equipment destination. All items must be protected from handling damage either by protective packing with cartons, crates, etc. or by securing to pallets. All material must be packed in a way that handling with forklift truck or crane is possible.

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.

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.

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

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

The packing list shall clearly show:

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


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

CONTRACTOR shall provide a Delivery Specification, which shall describe all loose items furnished in a completely or not completely assembled condition. Delivery Specification must clearly indicate PURCHASER's order number in the headlines and item number for each loose item shipped by the CONTRACTOR. One copy of the delivery specification shall follow the goods, one copy to be sent to the shipyard and one copy to be sent to the PURCHASER.

## 15 ASSEMBLY ASSISTANCE AND COMMISSIONING REQUIREMENTS

CONTRACTOR is responsible for assembly supervision of the equipment, including the assembly of components to be delivery loose (for example, some components of the pumps, like stuffing box; some vessels' internals, etc.).

CONTRACTOR shall provide preservation procedures for fire pumping units installed on its final location during shipyard construction phase.

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CONTRACTOR is responsible for pre-commissioning and commissioning supervision of the equipment/system. Final acceptance will be on satisfactory completion of commissioning tests as specified by PURCHASER.

## 16 CONTRACTOR RESPONSIBILITY

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

CONTRACTOR shall assume sole contractual and total engineering responsibility for the items supplied.

CONTRACTOR'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 any-CONTRACTORS relating to design and manufacturing.
- In all cases of conflict between this specification and applicable documents listed herein, the more stringent requirements shall prevail. In such cases, CONTRACTOR shall inform PURCHASER of the conflict and seek clarification.
- Installation at site by others, however, presence of supervision will be required.
- CONTRACTOR's responsibility shall also include Commissioning & Training for operation.

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

The technical proposal shall present the complete and detailed scope of supply and meet the requirements of all items of the respective Material Requisition (number and revision quoted) and its annexes, complemented by the Technical Clarification Circular Letters (number quoted), without any technical deviation.

Any exclusion and/or alternative to what is specified in the Material Requisition and its annexes, including the use of the bidders' standard and exclusive technology, shall be presented in a Deviation List, which only will be accepted by PURCHASER during the clarification phase, preceding the proposal presentation.

PURCHASER's acceptance of each item of the Deviation List will be through Technical Clarification Circular Letters, that will be issued to all bidders.

The Deviation List mentioned above shall contain, at least, for each requirement that the bidder intends to change:

- The document's description, code and section that contain the requirement;
- The reason for deviation, always indicating the requirements that are different to bidder's standard and the costs, schedule and technical benefits/impacts of the change;
- The bidder proposal