	TECHNICAL SPECIFICATION		Nº: I-ET-3000.00-5521-931-PEA-001	
	CLIENT: E&P ÁGUAS PROFUNDAS		SHEET: 1 of 19	
	PROGRAM: DESENVOLVIMENTO DOS SISTEMAS DE PRODUÇÃO		—	
	AREA: SISTEMAS SUBMARINOS			
TITLE: METOCEAN DATA ACQUISITION SYSTEM REQUIREMENTS		NP-1		DP&T/SUB/OPSUB/G DSO/OCN

REVISION INDEX				
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REV.	DESCRIPTION AND/OR ITEMS INVOLVED
0	ORIGINAL

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	14/03/2020								
PROJECT	GDSO/OCN								
EXECUTION	U4MC								
VERIFICATION	CMMX								
APPROVAL	BGS8								

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TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0
	Instrumentation and maintenance of platforms with the OCEANOP System	
	SHEET 2 of 20	
TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1
		DP&T/SUB/OPSUB/ GDSO/OCN

CONTENTS

1.	INTRODUCTION.....	3
2.	REFERENCE DOCUMENTS, STANDARDS AND CODES.....	4
2.1	ABBREVIATIONS.....	4
3.	TECHNICAL CHARACTERISTICS	5
4.	SPECIFICATIONS OF THE EQUIPMENT	6
4.1.	METEOROLOGICAL SENSORS	6
	4.1.1 <i>Wind Intensity and Direction</i>	6
	4.1.2 <i>Relative Humidity and Temperature Probe and Barometric Pressure Sensor</i>	7
	4.1.3 <i>Weather Display</i>	8
4.2.	OCEANOGRAPHIC SENSORS.....	8
	4.2.1 <i>Vertical Curret Profiler</i>	8
	4.2.2 <i>Current Meter</i>	8
	4.2.3 <i>Wave Measurements</i>	9
4.3.	INDUSTRIAL COMPUTER AND RACK.....	10
	4.3.1 <i>Industrial Computer</i>	10
	4.3.2 <i>Data viewing software</i>	12
	4.3.3 <i>Rack</i>	12
5.	REQUIREMENTS FOR THE DESIGN, MANUFACTURING AND INSTALLATION OF STRUCTURES	13
6.	DOCUMENTATION	14
7.	APPROVAL OF COMMISSIONING	16
8.	OPERATION AND MAINTENANCE.....	16
9.	ANNEXES	18
9.1.	ANNEX 1: BLOCK DIAGRAM EXEMPLIFYING THE CONNECTIONS BETWEEN THE METEOROLOGICAL AND OCEANOGRAPHIC INSTRUMENTS, THE COMPUTER AND THE PETROBRAS NETWORK.....	18
9.2.	ANNEX 2: MINIMUM REQUIREMENTS FOR PREVENTIVE AND CORRECTIVE MAINTENANCE	18



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0	
		Instrumentation and maintenance of platforms with the OCEANOP System	SHEET 3 of 20
		TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM	NP-1 DP&T/SUB/OPSUB/ GDSO/OCN

1. INTRODUCTION

This document provides the minimum requirements to be followed by the CONTRACTOR regarding design, manufacturing of structures and installation of the Environmental Data Acquisition System (ENV System) to be used in Floating, Production Storage and Offloading (FPSO). The abbreviation ENV refers to the word “Environmental”.

All details of designs, materials, structures, installation (including communication wiring and the installation of junction boxes), assemblies, documentations, tests and commissioning are included in the CONTRACTOR’s scope of deliveries, unless when specified otherwise herein. Moreover, the elaboration of a schedule for the delivery of designs, technical drawings, installation and commissioning reports and reports on test procedures are under the CONTRACTOR’s responsibility. All such documents are to be submitted for PETROBRAS’ approval.

The ENV System shall be designed, manufactured, tested and certified according to the Rules of the Classifying Organization, when applicable. The System functioning tests shall be done by the supplier.

Consulting PETROBRAS for approval of the designs, validation of the locations for installation of sensors and of the installation and recovery methods is part of the scope of this contract. The CONTRACTOR shall also provide any explanations requested by PETROBRAS. The confirmation of the acceptance of all requested documents shall be required for approval of the commissioning.

Upon commissioning, the ENV System shall be a Data Collection Unite (*or Unidade de Coleta de dados*, UCD in Portuguese) for PETROBRAS’ Meteorological-Oceanographic Data Collection Operational System (OCEANOP) operating in several exploration and production units. The UCD sensors, the data collection methods and the data acquisition and processing software shall be standardized in order to operate with the OCEANOP System.



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0	
		Instrumentation and maintenance of platforms with the OCEANOP System	SHEET 4 of 20
		TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM	NP-1 DP&T/SUB/OPSUB/ GDSO/OCN

Any modifications in this specification regarding the model or manufacture of any equipment or structure and the lack of parts of the system shall be submitted for PETROBRAS' approval.

2. REFERENCE DOCUMENTS, STANDARDS AND CODES

The installation and the equipment shall follow the rules of the Classifying Organization, as well as the following standards in their last version:

- IEC-60079 – Electrical Devices for Explosive Gaseous Atmospheres;
- NMEA 0183 – Standard for Maritime interface between electronic devices;
- MCA 101-1: *Instalação de Estações Meteorológicas de Superfície e de Altitude*;
- NORMAM-27: *Normas da autoridade marítima para homologação de helideques instalados em embarcações e em plataformas marítimas.*

2.1 ABBREVIATIONS

The following acronyms will be used herein:

Initials	Description
CCR	Central Control Room
IEC	International Electro-Technical Commission
NMEA	National Marine Electronics Association
OCEANOP	Meteorological-Oceanographic Data Collection Operational System
POS	Positioning Reference Systems
UCD	Data Collection Unit
EPTA	Telecommunication Services and Air Traffic Stations
ENV	Environmental Data Acquisition System
DADAS	DADAS - Environmental Monitoring Software
FAT	Factory Acceptance Test
UPS	Uninterruptible Power Supply
FPSO	Floating, Production Storage and Offloading
HMS	Helideck Monitoring System
AHRS	Attitude and Heading Reference System
GNSS	Global Navigation Satellite System



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0	
		Instrumentation and maintenance of platforms with the OCEANOP System	SHEET 5 of 20
		REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM	NP-1 DP&T/SUB/OPSUB/ GDSO/OCN

3. TECHNICAL CHARACTERISTICS

The ENV System shall measure, present, store and transmit meteorological data (wind intensity and direction, air temperature, atmospheric pressure and relative humidity of air) and oceanographic data (intensity and direction of sea currents; height, direction and duration of waves) to other systems. Sea currents data shall only be acquired by acoustic profilers at fixed current meters, whereas wave data by wave equipment and a multi-parameter station shall measure the meteorological data. The specification of the sensors are described below. Meteorological and oceanographic sensors shall be integrated by pre-established software (DADAS) running in a microcomputer compatible with the PETROBRAS system. The CONTRACTOR is responsible for the acquisition of the DADAS license. This system works without the intervention of an operator, and restarts automatically after power outages. The oceanographic and meteorological sensors shall be controlled solely by DADAS, whereas the use of computers or additional software shall not be accepted.

The ENV System shall receive the Positioning and Orientation data (from GNSS and AHRS sensors) from the POS System which shall be used for synchronization of time and bow angle, in order to correct information regarding the direction of meteorological-oceanographic sensors.

The data collected shall be processed and presented locally in real time on onboard displays. The data shall also be made available in the CCR and in the radio room via the reproduction of the video signal. Upon being received, the data are transmitted through the PETROBRAS corporate network to the base of the OCEANOP System onshore in order to be qualified and made available to several of PETROBRAS' applications.

The supply and installation of the microcomputer, of the meteorological and oceanographic sensors, of their electronic components, as well as of all maintenance structures and all other materials between the computer and the sensor are within the scope of the CONTRACTOR's services. Such materials include accessories for the installation of wiring, over-water and underwater communication cables, power cables, interfaces, racks, steel cables, switchboards, cages, crane, ballasts, connectors,



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0	
		Instrumentation and maintenance of platforms with the OCEANOP System	SHEET 6 of 20
		REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM	NP-1 DP&T/SUB/OPSUB/ GDSO/OCN

adaptors, junction boxes, foundations, structures, clamps and supports for fixating the sensors, sensor handling and recovery devices, tools, installation accessories, paints, ropes and any other necessary items.

The manuals of the sensors are to be followed, especially regarding the assembly inclination angle (minimum inclination is preferable) and rotation. The locations for the installation of sensors and the interaction of the underwater bundles of the current profiler with the underwater structures of the unit shall be indicated in a 3D simulation to be provided by the CONTRACTOR.

All equipment to be installed in the platform are presented below.

4. SPECIFICATIONS OF THE EQUIPMENT

4.1. METEOROLOGICAL SENSORS

The CONTRACTOR is responsible for being in compliance with the rules of EPTA category M, which require, among other things, that all meteorological sensors are periodically calibrated and that such calibration is certified by an institution or company accredited by the Air Force. Also, the CONTRACTOR is responsible for being in compliance with the rules of Helideck Monitoring System (HMS), established by “Marinha do Brasil” in NORMAM-27.

The signal of the meteorological sensors can be split with the CONTRACTOR’s system.

4.1.1 Wind Intensity and Direction

The CONTRACTOR shall acquire three wind sensors. One shall be installed at the highest point near the helideck, other at the highest point at the bow of the FPSO and another stand in spare. The wind sensor is not restricted by its make and model. It shall have the following specification or greater precision.

Take a measuring range from 0 to 60 m.s⁻¹ for intensity and 0 to 360° for direction; the accuracy of 0.3 m.s⁻¹ or 1% of reading for speed and 3° for direction; and the temperature limit of its operation is plausible with the expected temperature where the FPSO will operate.



TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5521-931-PEA-001	REV.	0
			Instrumentation and maintenance of platforms with the OCEANOP System	
	TITLE:		SHEET	7 of 20
	REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1	DP&T/SUB/OPSUB/ GDSO/OCN

Petrobras uses Anemometer 05106 *Marine Model* of R.M. Young with *line driver* and current loop outlet

Installation note: The sensors shall be installed in two different places, both of which shall be totally free of any interference for the circulation of the wind such as antennae radars, towers, buildings, stairs, chimneys or flares. The best places are the highest points in the units, which are generally the telecommunications towers. Even when on such towers, the anemometers shall be installed above any other structure, such as windsocks. Poles can be fixated in order to install the anemometers.

In order to facilitate the maintenance of the anemometers, the support pole should be telescopic with a mechanism to inhibit its rotation. The CONTRACTOR shall indicate the direction of the unit on the pole supporting the anemometer in order to facilitate the heading of the sensor during maintenance.

For this sensor, the CONTRACTOR needs supply the gyroscope system signal on the computer to correct the information measured.

4.1.2 Relative Humidity and Temperature Probe and Barometric Pressure Sensor

The CONTRACTOR shall acquire two sensors from each, one should be installed and other stand in spare. The sensors are not restricted by its make and model. It shall have the following specification or greater precision.

The relative humidity and temperature probe shall be installed with radiation shield. Take a measuring range from 0 to 100% to relative humidity and -10 to 50°C to temperature; Have accuracy of 1% of reading for relative humidity and of 0,3°C for temperature.

The barometric pressure sensor shall be installed with pressure port. Take a measuring range from 500 to 1100 hPa; with accuracy of 0.3 hPa; and the temperature limit of its operation is plausible with the expected temperature where the FPSO will operate.

Petrobras uses relative humidity and temperature probe of R.M. Young model 41382 with a “radiation shield” model 41003P or VAISALA model HMP155 with a “radiation



TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5521-931-PEA-001	REV.	0
	Instrumentation and maintenance of platforms with the OCEANOP System		SHEET	8 of 20
	TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1 DP&T/SUB/OPSUB/ GDSO/OCN	

shield” model DTR503 and barometric pressure sensor of R.M. Young model 61302L with pressure port model 61002 and weather-proof box model 61360.

Installation note: These sensors shall be installed far from heat sources such as air vents and exhausts. Preferably, in order to facilitate maintenance, they should not be installed on top of the telecommunications tower together with the anemometers.

4.1.3 Weather Display

Weather display should connect the sensors to the computer. The weather display shall show and transmit weather data through two serial ports in the format below.

II.I DDD II.I DDD TT.T UUU PPPP.P, where:

II.I: wind intensity (in $m.s^{-1}$);

DDD: wind direction (in degrees);

TT.T: air temperature (in °C);

UUU: relative humidity (in %);

PPPP.P: atmospheric pressure (in mb).

Petrobras uses R. M. Young model 26800H Programmable Translator, interconnection cables and line filters.

Installation note: Preferably, weather display should be installed in the rack dedicated to the ENV system. Its setting shall be in compliance with the DADAS requirements and, for these purposes, PETROBRAS can be consulted in order to provide guidance about this matter.

4.2. OCEANOGRAPHIC SENSORS

4.2.1 Vertical Current Profiler

The CONTRACTOR shall acquire an Acoustic Doppler Current Profiler (ADCP) that has at least a maximum range of 600 m. Whereas operating should profile at least 400 m.



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV.	0
		Instrumentation and maintenance of platforms with the OCEANOP System	
		SHEET	9 of 20
TITLE:		NP-1	
REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		DP&T/SUB/OPSUB/ GDSO/OCN	

The Vertical Current Profiler shall be capable of configuring the depth cell size between 8 and 20 m, velocity accuracy of 1% of measured value $\pm 5 \text{ mm.s}^{-1}$, velocity resolution of 1 mm.s^{-1} and velocity range of $\pm 5 \text{ m.s}^{-1}$.

There are two Vertical Current Profilers that Petrobras uses, Acoustic Doppler Current Profiler (ADCP) models WorkHorse Long Range 75 kHz of RD Instruments or Signature55 of Nortek.

The following items are included: maintenance kit, operation manual, transducer serial outlet and control cable of the ENV system with a connection for underwater extensions at the tip of the transducer, a power cable, an interconnection cable, spare parts and the software of sensors.

Installation Notes: Instrumentation places with obstacles to the acoustic bundles and *side lobes* of the current profilers should be avoided. The support structure of the sensors shall be constructed and positioned so as to not create this type of obstacle.

4.2.2 Current Meter

The CONTRACTOR shall install a Current Meter that has accuracy of 1% or 5 mm.s^{-1} to velocity and 2° to direction; range of 0 to 5 m.s^{-1} to velocity and 0 to 360° to direction.

As a reference, PETROBRAS uses the Aquadopp Mooring of Nortek.

Installation notes: Current meter must be installed in the same cage as the current profiler.

4.2.3 Wave Measurements

The CONTRACTOR shall install an equipment to evaluate the wave direction, period, height. In order to better quantify the wave measurements, the equipment needs to remove the FPSO movements from the data. Wave data has range of 0 to 30 m to height, 3 to 30 s to period and 0 to 360° to direction.



TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5521-931-PEA-001	REV.	0		
			Instrumentation and maintenance of platforms with the OCEANOP System		SHEET	10 of 20
			TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1 DP&T/SUB/OPSUB/ GDSO/OCN	

The equipment shall be installed following the guidelines established by the manufacturer, especially in relation to the recommended height in relation to sea level and the free area of structures around the sensor.

The Wave equipment module, installed externally, shall be controlled solely by the DADAS software.

Installation Notes: installation should be as recommended in the installation manual. Preferably, in order to facilitate of maintenance, they should be installed for easy access to your modules.

4.3. INDUSTRIAL COMPUTER AND RACK

4.3.1 Industrial Computer

Two microcomputers shall be delivered: one should be installed and the other shall be kept standby for exclusive use of the ENV System. These computers shall receive the standard PETROBRAS image installed by PETROBRAS, and shall be connected to the PETROBRAS network and be used exclusively as part of the OCEANOP System.

The microcomputers shall have the minimum requirements below:

- Processor: Clock of 3 GHz or high;
6 MB cache or high;
64 bits;
Shall support virtualization technology.
- Memory: 8 GB or high;
Standard DDR3 or high;
Frequency 1600 MHz or high.
- Hard disk: 1TB;
16 MB cache;
7200 RPM;
Interface SATA.
- Watchdog Card;
- 4 USB v3.0 ports;
- Multi-serial board: with 8 ports ;



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0
Instrumentation and maintenance of platforms with the OCEANOP System		SHEET 11 of 20
TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1
		DP&T/SUB/OPSUB/ GDSO/OCN

standards RS-232 / RS-422 / RS-485 ;
128 bytes Tx/Rx FIFO;
Transmission of 921.6 Kbps or higher;
Output cable DB-9;
All ports shall be configurable.

- 3 Ethernet ports (10/100/1000baseT) ;
- Video card with PCI Express X16 with 01 GB RAM (minimum) ;
- DVD-ROM drive;
- Operational system: Windows 10 ultimate 64 bit license in Portuguese;
- Keyboard with built-in mouse for 19" rack;
- industrial LCD monitor for assembly on 19" rack ;
- 1300 VA on-line UPS unit with automatic restart.

Additionally, an Ethernet converter (e.g., MOXA NPort 5600) with 8 serial ports is required. The NPort will connect all the sensors.

The computer shall be connected with the meteorological station and AHRS via standard serial RS-232 with the DB9 connector. All sensors installed shall provide data exclusively to the computer dedicated to the ENV System via the DADAS software. For all sensors with communication done with other protocol, the CONTRACTOR shall provide the proper converters to translate the signals to RS-232. No other types of connection shall be accepted.

The CONTRACTOR shall request PETROBRAS for the sensor test procedure according to the setting accepted by DADAS. These tests can be performed in the software of the manufacturers of each sensor.

The computer of the ENV System shall be connected to the platform's UPS and to a separate individual UPS installed in the rack.

The industrial microcomputers and all sensor control equipment shall be installed in a 19" rack. At PETROBRAS' discretion, new instrumentations may receive Ethernet-serial conversion modules as substitutes for the computers. The CONTRACTOR shall acquire both (computer and conversion module specified by PETROBRAS). The cost of



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0	
		Instrumentation and maintenance of platforms with the OCEANOP System	SHEET 12 of 20
		TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM	NP-1 DP&T/SUB/OPSUB/ GDSO/OCN

the Ethernet-serial conversion modules shall be similar to that of the computers specified above.

The CONTRACTOR is responsible for supplying all software and hardware as well as for their settings, so as to unite the data from the ENV System and present them in appropriate format in the computer. This includes all corresponding integrations.

4.3.2 Data viewing software

The CONTRACTOR shall provide the meteorological-oceanographic data in the acquisition and display software DADAS by A+D (www.automasjon.no) in PETROBRAS' version. For this, a software license shall be bought and installed in one of the computers. The software shall be kept for the whole system operation period. The purchased license shall be able to work with 500 variables and 6 simultaneous Clients.

The system (computer + DADAS) shall be already installed and the sensors shall be already acquiring and storing data. The CONTRACTOR shall be responsible for the acquisition and installation of a remote access program that allows PETROBRAS to access the computer onboard using a TCP/IP protocol. This will enable GDSO/OCN to modify the settings of the sensors, if it is necessary. Moreover, the CONTRACTOR shall provide the meteorological-oceanographic data measured via the display in an FTP with ascii or similar format, to be agreed upon later. For more details about the access and availability of data, GDSO/OCN shall be consulted.

4.3.3 Rack

The rack provided and installed by the CONTRACTOR shall be powered via the UPS in the Platform with 120 VAC/60Hz or 220 VAC/60 Hz, and be very well signaled. In order to meet the needs of the equipment and sensors, other voltages (12 VDC and 24 VDC) shall be obtained internally in the package with the use of rectifiers. The ENV microcomputer and the weather display shall be installed in the rack and connected to the environmental sensors. The rack shall be installed close to the POS rack in the Telecommunication room (TER).



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0
		Instrumentation and maintenance of platforms with the OCEANOP System
	TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM	NP-1

The rack shall meet the specifications below: industrial standard for dust-proof 19" rack, key-locked cabinet for disk drives, rubber plugs for fixation of expansion boards, shock-proof support with dampeners for hard drives, ventilation forced with positive internal pressure creation, removable filters, 500W energy source or similar.

Annex 1 presents a diagram exemplifying the connections between the meteorological and oceanographic instruments, the computer and the PETROBRAS network.

5. REQUIREMENTS FOR THE DESIGN, MANUFACTURING AND INSTALLATION OF STRUCTURES

Surface oceanography instrumentation

The support and fixation structures of the oceanographic equipment shall be constructed and installed according to the premises below:

- they shall provide safe ways of recovering equipment for maintenance and cleaning, such as proper work platforms and safety brakes for the crane;
- they shall have handling and safety devices installed, such as, an advanced floor with a manhole or a tilting frame for oceanographic sensors;
- in places with the least possible vibration;
- in such a position that the sensors do not receive any interferences and do not interact with parts of the unit, such as arms, columns, anchoring lines, risers, thrusters, hull, etc. A 3D simulation intended for evaluation provided by the CONTRACTOR is essential in order to verify the interaction of the underwater bundles of the current profiler with the underwater structures;
- in conditions that allow the sensors to be at least 30m deep and at least 8m below the hull in order to avoid operation above water due to the action of waves and tides and to avoid any influence from parts of the platform, such as arms, anchoring lines, hull and other underwater parts of the unit. Places such as the bow and the stern are the most indicated due to the inclination of the hull;



TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5521-931-PEA-001	REV.	0
			Instrumentation and maintenance of platforms with the OCEANOP System	
	SHEET		14	of 20
	TITLE:		NP-1	
		DP&T/SUB/OPSUB/ GDSO/OCN		

- so as to minimize all movements the sensors shall be subjected, structures fixed in only one support cable shall not be acceptable, since they allow for the rotation of the sensors;
- they shall meet the needs for prevention and protection against damages caused by hitting other structures, as well by other vessels operating near the unit;
- the underwater electric cables shall be inserted in protective hoses or otherwise electromagnetic cables shall be used the cage shall be hollow and meshed so as to reduce the water carryover area.
- ballast shall be built in rings to ease the assembly during movement;
- it's suggested the use of hoses to protect the submerged cable
- all materials (equipment cage, ropes, cables, screws, parts, nuts, shackles, etc.) provided by the CONTRACTOR shall be made of stainless steel 316L, except for ballasts, which may be made of other materials other than ferromagnetic materials;
- technical designs shall include the installation of junction boxes, which should be as close as possible of the sensor installation places, and shall have protection and safety degrees compatible with the characteristics of the places where they are being installed;
- the space dedicated to the crane for lifting oceanographic sensors shall be established as close as possible to the location where the sensors are to be installed.

6. DOCUMENTATION

The CONTRACTOR shall present a Technical Plan which encompasses the electrical and mechanic plans for the installation of the meteorological station and of the oceanographic sensors. Structural and electrical calculations, respective calculation memories, installation quotas for each individual sensor in relation to the mean sea level,



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0
Instrumentation and maintenance of platforms with the OCEANOP System		SHEET 15 of 20
TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1
		DP&T/SUB/OPSUB/ GDSO/OCN

passage and junction box designs, electrical diagrams, outlining of the wiring, tridimensional representation of the underwater installation (including the underwater structures of the unit and their interaction with the sensors, including the acoustic bundles of the ADCPs) and other items of the project shall be included. The places where the sensors, junction boxes, racks, structures, etc. are to be installed shall be described. Installation, assembly and recovery procedures for the structure in the unit shall also be indicated.

The CONTRACTOR shall submit the Technical Plans to PETROBRAS at the beginning of instrumentation. PETROBRAS may request modifications and, if this is the case, the CONTRACTOR shall submit new versions until reaching final approval. Even after the project is approved, modifications in the structure can be requested if the instrumentation is not done according to the project if the data collected in the pre-acceptance of the commissioning indicate the existence of interferences or other problems of any nature. Upon approval, the CONTRACTOR shall provide an updated version of the project (AS-BUILT).

The CONTRACTOR shall also provide the following documentation:

- Schedule of the execution of the actions specified herein;
- Photographs of the installations before the unit leaves the shipyard;
- Hook up drawings;
- Report on the factory acceptance tests (FATs);
- Equipment testing procedures regarding equipment in the unit;
- Technical sheets, manuals and calibration certificates for each sensor;
- Installation and commissioning reports.



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV.	0
		Instrumentation and maintenance of platforms with the OCEANOP System	
		SHEET	16 of 20
TITLE:		NP-1	
REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		DP&T/SUB/OPSUB/GDSO/OCN	

7. APPROVAL OF COMMISSIONING

The CONTRACTOR shall submit the entire system specified herein to approval by the Oceanography Management, which shall evaluate the designs, the manufacturing and installation of the structures and the data collected for approval of the commissioning.

After the installation of the sensors, the data collected shall go through an evaluation period of at least one month. In such period, the data shall be continuously approved by the consistency rules of PETROBRAS. If PETROBRAS does not approve the data, the issues are to be solved as soon as possible, and a new homologation process will begin.

8. OPERATION AND MAINTENANCE

The manufacturing and the installation of the ENV System structures under the responsibility of the CONTRACTOR shall be done in such a way as to facilitate maintenance and make it safe and effective. Means for recovering the sensors for cleaning and maintenance shall be made available in proper work platform and with safe devices for handling and lifting equipment.

The owner of the instruments shall be responsible for the operation and preventive and corrective maintenance of the ENV System. After the instrumentation by the CONTRACTOR and the approval of the commissioning, maintenance shall be done by PETROBRAS' units. In chartered units, The CONTRACTOR shall be responsible for the maintenance of the system.

The guidelines regarding the minimum requirements for corrective and preventive maintenance of the meteorological-oceanographic system to be met by the CONTRACTOR can be found in Annex 2 of this Technical Specification. PETROBRAS shall verify the quality of data and may request corrective interventions whenever necessary.

The CONTRACTOR shall inform PETROBRAS about the dates of the equipment maintenance events in advance. In contingency situations, a non-stop delivery of data



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0
Instrumentation and maintenance of platforms with the OCEANOP System		SHEET 17 of 20
TITLE:	REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM	NP-1
		DP&T/SUB/OPSUB/ GDSO/OCN

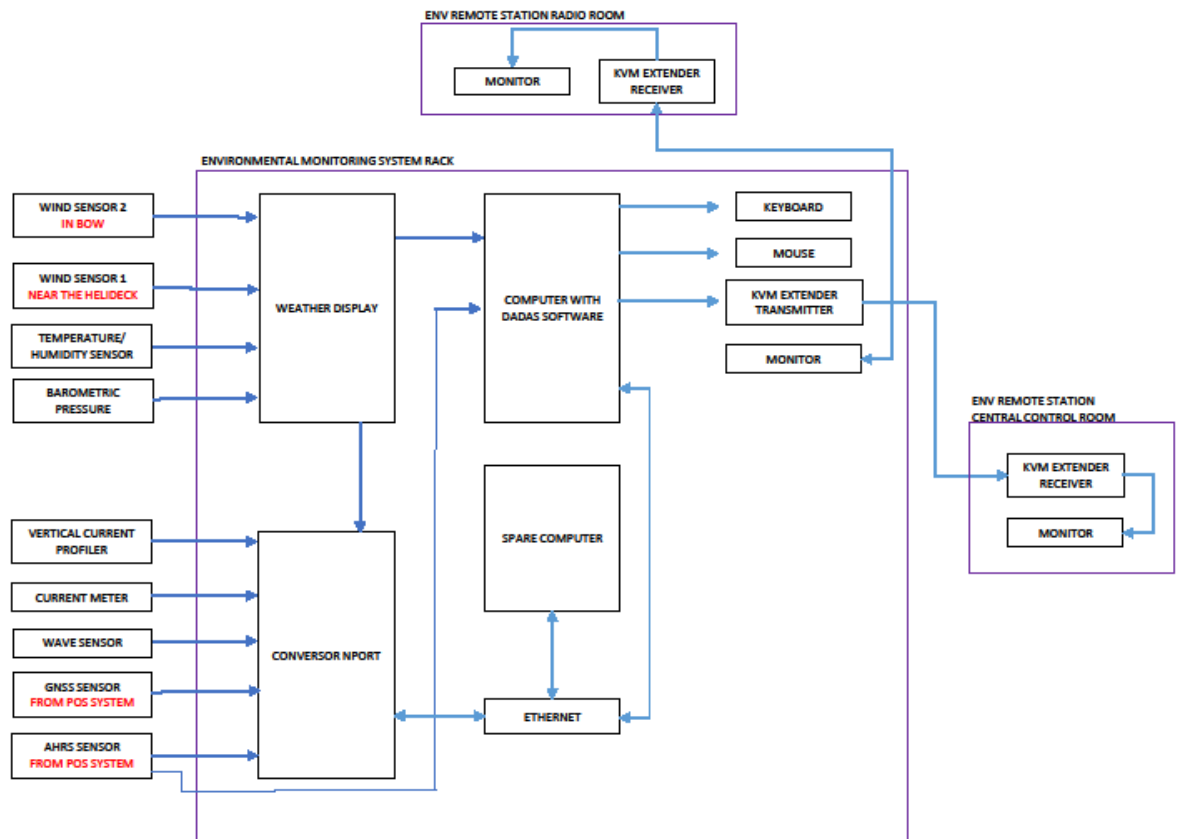
due to maintenance may be requested, even if the contingency does not directly involve the Unit.



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0
		SHEET 18 of 20
		NP-1
Instrumentation and maintenance of platforms with the OCEANOP System		DP&T/SUB/OPSUB/GDSO/OCN
TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		

9. ANNEXES

9.1. ANNEX 1: BLOCK DIAGRAM EXEMPLIFYING THE CONNECTIONS BETWEEN THE METEOROLOGICAL AND OCEANOGRAPHIC INSTRUMENTS, THE COMPUTER AND THE PETROBRAS NETWORK.



9.2. ANNEX 2: MINIMUM REQUIREMENTS FOR PREVENTIVE AND CORRECTIVE MAINTENANCE

It is required for the UCDs preventive maintenance in order to keep operating well at least every six months in the meteorological sensors and every three months in the oceanographic sensors. Applicable penalties shall be applied if the CONTRACTOR does not provide the necessary resources in due time. The CONTRACTOR shall provide all necessary materials such as tools, paints, connectors and other consumables or spare parts. The services encompass items intended for maintaining the correct operation of the sensors, including, without limitation:



TECHNICAL SPECIFICATION	Nº	I-ET-3000.00-5521-931-PEA-001	REV.	0
	Instrumentation and maintenance of platforms with the OCEANOP System		SHEET	19 of 20
	TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1	DP&T/SUB/OPSUB/ GDSO/OCN

- Cleaning of all soot and sea weathering found in above-water materials, with verification of their functioning conditions, especially sensors, moveable parts, tubes, cables and connections;
- Cleaning of all bio-scaling found in underwater materials, especially on sensors, on their transducers and connectors, and in data transfer cables, power cables and support cables;
- Verification of the weathering and corrosion of the instrument panel (including scrapers, clamps, acetal bases, fixation bolts, ropes and other parts), as well as replacement of damaged items;
- Verification and replacement of nuts, shackles and latches used for supporting the sensors;
- Verification and replacement of sacrificial anodes and other consumables;
- Maintenance of proper painting of the parts of the support structures, so as to prevent corrosion;
- Verification of the structures and support cables (including shackles, nuts, shoe, etc.);
- Verification of the condition of the crane regarding wearing and corrosion (including its screws, welded parts and base), its fixation to the base and the integrity of the braking system;
- Verification of the voltages in the energy cables;
- Verification, lubrication and replacement (whenever necessary) of all items in the junction boxes, including connectors, terminal boards and screws;
- Provision of spare parts (whenever necessary) regarding all models of structures and all types of materials: cranes, panels, cages, ballasts, boxes, cables, connectors, computers, sensors, etc.;
- Verification of the electric power differences in data cables and, if any are found, verification of the terminals and of the continuity of earthing cables;
- Verification and replacement of connectors, if necessary; and



TECHNICAL SPECIFICATION	Nº I-ET-3000.00-5521-931-PEA-001	REV. 0
Instrumentation and maintenance of platforms with the OCEANOP System		SHEET 20 of 20
TITLE: REQUIREMENTS OF METOCEAN DATA ACQUISITION SYSTEM		NP-1
		DP&T/SUB/OPSUB/GDSO/OCN

- Verification of the communication of sensors and execution of dielectric hardness and continuity tests.

The manufacturer's guidelines shall always be followed for the preventive maintenance of the sensors (replacement of *o'rings*, verification of the conditions of screws, pressure membranes, silica gel envelopes, etc.).

Preventive maintenance is necessary, but does not necessarily guarantee good functioning of the sensors. Therefore, corrective maintenance involving even the replacement of structures and sensors may be necessary at any moment, whenever the data present any type of problem in the sensors and/or in the structures. Before any maintenance, whether preventive or corrective, PETROBRAS shall be notified and after such maintenance, a report that describes the actions performed and provides the expectation of any future actions (if necessary) shall be generated.

Small interventions guided by PETROBRAS may be needed, such as restarting the computer with the DADAS program or with the translator. In order to perform such interventions, one or more people on board may be trained by PETROBRAS.