
	TECHNICAL SPECIFICATION		No.: I-ET-3000.00-8222-941-PJN-001		
	CLIENT: E&P		SHEET: 1 of 23		
	JOB: LABORATORY				
	AREA: PETROBRAS				
UN-BC/SE/LFCAM	TITLE: LABORATORY - EQUIPMENT			NP-1	
UN-BC/SE/LFCAM					
INDEX OF REVISIONS					
REV.	DESCRIPTION AND/OR REVISED SHEETS				
0 K	<p>Original Issue. Sheet 2/22 (2.2.6.1); sheet 4/22 (2.2.1.1); sheet 6/22 (2.2.1.6); sheet 8/23 (2.2.2.2); sheet 14/22 (2.2.7.2 to 2.2.7.3); sheet 15/22 (2.2.7.4 to 2.2.7.9); sheet 16/22 (2.2.7.10 to 2.2.7.12); sheet 17/22 (2.2.7.13 to 2.2.7.15); sheet 18/22 (2.2.1.1; 2.2.1.2; 2.2.1.4 to 2.2.1.8; 2.2.2.3; 2.2.2.6; 2.2.2.8); sheet 19/22 (2.2.4.1; 2.2.5.1; 2.2.6.1; 2.2.7.2 to 2.2.7.4); sheet 20/22 (2.2.7.5 to 2.2.7.15); sheet 21/22 (4.10 to 4.13).</p>				
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EXECUTION	UPQT	UPQT			
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1. OBJECTIVE

This technical specification establishes the basics requirements for equipment to be installed on LABORATORY, located on offshore units.

This technical specification is applicable only to laboratories designed from the date of issue of the original version.

2. LABORATORY EQUIPMENT SPECIFICATION

2.1. General

The Laboratory equipment description shall be followed strictly in order to comply with this document.

All components shall be adequate to the following conditions:

- Corrosion resistance.
- Chemical resistance to products used in the laboratory.
- Compatible with the laboratory tasks.

All equipment must have commercial representation in Brazil, to facilitate its maintenance and replacement.

All equipment must be calibrated and the results of the calibration must meet Petrobras requirements.

The equipment must be installed, calibrated, and commissioned in the laboratory by the supplier.

The equipment must have a calibration certificate with an expiration date of not less than 10 months from the closing date of the laboratory acceptance and performance tests.

All calibrations of laboratory equipment that measure density, pressure and temperature must be performed by accredited laboratories. In Brazil, the laboratory will be a member of RBC (Brazilian Calibration Network). In other countries, a signatory body of ILAC (International Laboratory Accreditation Cooperation) or IAAC (InterAmerican Accreditation Cooperation) must accredit the laboratory.

All utility lines shall have general valves that allow fast locking in the case of leakage or accident in the Laboratory.

2.2. Equipment description and related systems

2.2.1. Oil treatment, storage and transfer system

2.2.1.1. Water bath

Purpose: Water bath for preheating of samples.

Standard Test Method: ASTM D4007.

Description: Calibrated digital water bath with high clearance lid. Display LCD; working temperature range ambient +5 to 100 °C; temperature stability $\pm 3,0$ °C; reservoir capacity 27-30 liters; reservoir material stainless steel.



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Over-temperature protection and failsafe heater control. Reservoir drain. Power supply 220V / 60 Hz; IP 20.

Two stainless steel test tube racks to accommodate eight conical centrifuge tubes, ASTM D4007, each.

The temperature must be calibrated at 60 and 70 °C.

2.2.1.2. Oil Test centrifuge

Purpose: Centrifuge for water and sediment (BS&W) analysis in oil.

Standard Test Method: ASTM D4007.

Description: Calibrated heating centrifuge fitted with at least six-place swing out rotor and universal bucket assembly to accommodate adaptors and cushions suitable for 8-inch conical borosilicate glass centrifuge tubes. Heated chamber, ambient to 80°C ± 2°C. Pre-heat facility to ensure bowl is at test temperature prior to test. Motor driven lid latch with a safety interlock to prevent centrifuge operation while the lid is unlocked, imbalance detection, and over-temperature protection for both the motor and the chamber. Rotational speed up to 3000 rpm. Relative Centrifugal Force (RCF) up to 2200g. Power supply: 220/240V, 50/60Hz. Noise levels below 55 dB. The temperature must be calibrated at 60 and 70 °C. Calibration Certificate should include rotation speed and time.

2.2.1.3. Digital thermometer

Purpose: Thermometer for the measurement of the temperature of samples and general use.

Description: Calibrated digital Infrared and Contact Thermometer. Two-in-one contact and non-contact thermometer. Infrared temperature range: at least ambient to 100°C. Infrared accuracy: ±1.0°C. Display resolution 0.1°C. Thermocouple Type-K input temperature range: at least ambient to 100 °C. Thermocouple Type-K input accuracy: ±1.0°C.

2.2.1.4. Salt in crude analyzer

Purpose: It is used to determine salt content in crude oil.

Standard Test Method: ASTM D3230.

Description: Salt in crude analyzer calibrated for use in conformity to ASTM D3230. Supplied with beaker and sensor support stands. Interchangeable plug-in sensor. SaltCheck Verification Tool (0, 30 e 190 g/m³). Conductivity Range: 0.0 to 430.0 g/m³ (Resolution: 0.1 g/m³). Temperature Range: -20 to 150 °C (resolution: 0.1 °C). Power Requirement: Power module supplied to operate the instrument on line power (100-240Vac, 50/60 HZ).

2.2.1.5. Digital density meter

Purpose: Density meter is used to measure the density of liquids.

Standard Test Method: ASTM D4052 and ASTM D5002.

Description: Calibrated digital density meter; manual sample injection; analytical principle: Oscillating U-Tube; measurement range: 0 to 3 g/cm³;



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temperature range: 0 to 90 °C (by Peltier elements); pressure range: 0 to 10 bar; density accuracy: 1×10^{-4} g/cm³; Density Repeatability: 5×10^{-5} g/cm³; temperature accuracy: 0.03 °C; automatic bubbles detection; viscosity correction. For exceptional conditions, like crude oils with high viscosity (> 20.000 mPa.s), is required a syringe heating accessory designed for heating the sample inlet and the sample outlet. The temperature must be calibrated at 20 °C. Perform calibration of the density at the temperature of 20 °C at four measurement points: a point between 0.7 and 0.8 g/mL; a point between 0.8 and 0.9 g/mL; a point between 0.9 and 1.0 g/mL and a point between 1.2 and 1.31 g/mL. Portable densimeters are not allowed.

2.2.1.6. Potentiometric titrator

Purpose: It is used to perform acid-base titrations, titrations of mercaptans and hydrogen sulfide in oil, gas and water and to perform chloride titrations with potentiometric indication.

Standard Test Method: ASTM D3227, UOP163

Description: Titrator for potentiometric titration with two measuring interfaces for use with Dosino dosing systems. Plug & play sensors; touchscreen display; LIMS-integration by USB port. Complete set of accessories necessary to perform acid-base titrations, titrations of mercaptans and hydrogen sulfide derived from crude oil according to ASTM D3227 and UOP163 and to perform chloride titrations with potentiometric indication. Volumetric calibration and performance certificate are required.

2.2.1.7. Vapor pressure tester

Purpose: vapor pressure tester for the automatic determination of the vapor pressure of crude oil.

Standard Test Method: ASTM D6377.

Description: Calibrated vapor pressure tester. Temperature range measured: 0 to 120°C (user programmable). Temperature stability: $\pm 0.01^\circ\text{C}$. Temperature profiles: single temperature, stepped or ramped. Pressure range: 0 to 1000 kPa (0 to 145 psi). Pressure resolution: 0.1 kPa. Pressure tolerance: 0.1 kPa. Vapor-Liquid ratio: 0.02/1 to 100/1, adjustable per selected method. Repeatability: ± 0.3 kPa (0.04 psi). Reproducibility: ± 0.7 kPa (0.10 psi). No vacuum pump or sample preparation necessary. Integrated shaker for crude oil samples.

Automatic piston lubrication. LIMS-integration. Power Requirements: 100-240 V AC, 50-60Hz. Field Application: DC/AC Power Converter 12V / 200W. Temperature, pressure and vapor pressure calibration are required.

2.2.1.8. Cylinders for pressurized oil sampling

Purpose: sampling container for oil.

Description: Set of cylinder, three valves (installed) and case.

a) Cylinder for sampling of pressurized petroleum under process conditions; rated capacity of 750 ± 50 mL, made of AISI 316 stainless steel and stainless steel alloys, consisting of cross-sectional lids that prevent deformation of the cylinder during heat treatment of the sample for analysis,



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which occurs by exposing the cylinder to working pressures up to 3200 psi and temperatures up to 140 ° C for 36 hours; with internal movable and magnetic plunger, the plunger seals and covers being made of viton o'rings resistant to the conditions of pressure and working temperature; with 01 nozzle on the pressurizing chamber cap with ¼ "NPT female thread and 02 nozzles on the sample chamber cap with ¼" female NPT thread. Composed internally of sample mixer in brass metallic ball shape. Both sides of the cylinders shall contain a protective helmet to protect the valves. Approximate dimensions of 75 cm X 6 cm without protective helmet, and 80 cm X 10 cm with protective helmet. Weight up to 12 kg. Serial number and identification: longitudinal low voltage dyeing to the body, manufacturer's serial number and customer identification code according to the latest bidding document or document.

The cylinders must be hydrostatically tested (individually) according to the DOT - 3A 5000 standard, accompanied by an individualized Hydrostatic Test Certificate and individualized material certificate.

b) Needle valves. The cylinder should be provided with three needle valves, integral bonnet type; in 316 stainless steel; with stainless steel V-rod tip; 90 degree angular pattern; with ¼ "NPT male inlet; with measured output ¼ "NPT female; maximum working temperature 232 degrees Celsius to 4130 psi; working pressure of at least 5000 psi at 37 ° C; PFA 2-piece chevron-style stem seal; 3.2 mm hole; with replacement of the original valve lever by a short stainless steel round vertical rod with tork key connection at the top.

c) Carrying case in gray color in the dimensions of 82 cm in length x 28 cm in width x 20 cm in height, 4.5 mm walls in injected plastic of high resistance (ABS) with treatment against UV rays. Fittings for linear and square stacking of 4 or more cases supporting maximum stacking of 10 cross-units; with high density foam internal (foam in black color) suitable for cylinder weight and dimensions (on lid, cradle and upper ends and lower); 316 stainless steel folding handle (with bolts, parlock nuts and reinforcement); 316 stainless steel hinges (bolt-fastened, with parlock nuts and reinforcement); pressure clamps with pressure adjustment and steel closing height stainless steel 316 (fixed with bolt, parlock nuts and reinforcement); with metal feet and identification plate in 316 stainless steel on the outside front.

2.2.2. Gas treatment system

2.2.2.1. Portable micro Gas Chromatography (GC) natural gas analyzer

Purpose: Micro GC is used for the analysis of natural gas composition.

Standard Test Method: ABNT NBR 14903 or ASTM D 1945.

Description: Portable micro GC for the analysis of natural gas equipped with four independent column channels. Each column channel shall be a complete, miniaturized GC with electronic carrier gas control, micro-machined injector, narrow-bore analytical column and micro thermal conductivity detector (μ TCD). Sample inlet heated from the rear serving all channels. Micro GC channel, MS5A PLOT, 10m, heated injector, backflush,



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ultimetal sample path factory installed; column: Molecular Sieve 5A PLOT, 0.25mm ID, 10m. PPU-UM 10m HI-BF channel. Micro GC channel, CP-Sil 5 CB, 4 m, heated injector, backflush, factory installed; column: CP-Sil 5 CB, 0.15 mm ID, 4 m. Micro GC channel, CP-Sil 5 CB, 10m, heated injector, ultimetal sample path; factory installed; column CP-Sil 5 CB, 0.15 mm ID, 10m. Field case for the 4-channel micro GC, equipped with two gas cylinders for either dual gas or double volume single gas and external charger for micro GC battery pack. Genie 170 Std filter w/ rotameter and bracket. The equipment shall be supplied with software and licenses.

2.2.2.2. Explosion-proof hot air oven

Purpose: warming up gas samples.

Standard Test Method: ABNT NBR 14903 or ASTM D 1945.

Description: Explosion-proof interior hot air oven with forced air circulation system; outer layer with anti-corrosive painting; stainless steel at inner layer; thermal insulation walls; 1 door with thermal seal; calibrated temperature range: 50 to 100 °C; maximum temperature electronic and hydraulically limited with alarm and interlock to stop the heating set; additional and independent hydraulic interlock into inner chamber to guarantee to stop heating; air blower interlocked to alarm and stop heating; constant circulating air flow 7,2 m³/h; air inlet with filter; air outlet and inlet vanes lockable to avoid improper closing; automatic temperature control with 0.1 °C of resolution; digital configurable heating and cooling rates; digital configurable alarm for min, max temperatures and temperature differentials; RTD sensor PT100 type; 2 internal removable shelves equally spaced by 150 mm; 20 kg minimum loading per shelf; bench type with adjustable rubber basis; explosion proof; working with flammable products; 220 Vac; IP 20; 3,000 W; with safety mechanism for relieving the gas in the event of explosion of gas cylinders with gas relief to the top, at 0,5 kgf/cm², and that ensures no projectiles generation to protect the operator; oven with 5 kgf/cm² of rupture limit; door lock system with duplicity and fail-safe mechanism.

Note 1: A dedicated exhaust duct must be installed at the air outlet of the oven in order to exhaust possible gas leakage.

Note 2: Alternatively, five flexible heaters with temperature controller could replace the hot air oven.

2.2.2.3. Cylinders for gas sampling

Purpose: Cylinders for natural gas sample collection and analysis.

Description: a set of cylinder and valves (installed) DOT certified; and carrying case.

a) Cylinder for sampling of natural gas; made of AISI 316L stainless steel; seamless seam with smooth inner neck transition (no soldering); nominal working pressure 5000 psig (344 bar); working temperature in the range of -50°C to 150°C; nominal capacity 300 mL; with upper and lower cylinder nozzles with cold-formed ¼ "NPT female threads; with smooth internal finish and passivated by electropolishing; without carrying handle.. The total length of the installed assembly (cylinder, valves, adapters and CAPs installed) of



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maximum 550 mm, diameter of maximum 70 mm, thickness of walls according to design and meeting DOT - 3A 5000 standard; maximum weight of 4 kg. Recordings shall be made on the cylinder body with reference to the DOT standard of manufacture and testing; Individual identification to be supplied by Petrobras, working pressure, company logo, hydrostatic test date and other technical characteristics of the cylinder. Each cylinder shall have an individual identification consisting of sequential numbering and platform acronym. The working pressure and hydrostatic test date shall also be stated. The cylinders must be hydrostatically tested (individually) according to the DOT - 3A 5000 standard, accompanied by an individualized Hydrostatic Test Certificate and individualized material certificate.

b) Straight needle valves. The cylinder is supplied with 02 (two) straight needle valves with stainless steel body ASTM A479 Gr.316, integral cast iron, ASTM A276 Gr.316 stainless steel rotary rod with soft tip in PCTFE, nominal working pressure of 5000 psig and temperatures working in the range of - 50 ° C to 150 °C. The stem seal made by acetone-resistant o-ring (in Kalrez or similar material with proof) and the back type ensures a full seal in the open position of the valve. Valve inlet connections with ¼ "NPT male cold rolled thread and ¼" NPT male outlet fitting. The drive is made by anodised aluminum round handle. The valves are mounted on the cylinder nozzles with teflon tape and are supplied with Individual Material Certificate. It should be supplied with 2 ¼ "NPT female x JIC 4 male stainless steel fittings screwed into the valves and with stainless steel JIC 4 female cap screws (CAPs) screwed onto the male JIC 4 ends of the adapters.

c) Carrying case. Made of "super light" composite polymer body, type HPX² (formed from a blend based on polypropylene); Gray color. Dimensions of the case (W x H x D): internal (66 x 35.6 x 21.3 cm), external (73.3 x 42.6 x 23.2 cm); cover depth: 5.1 cm; depth of body: 16.2 cm; total depth: 21.3 cm. Weight with foam: 5.3 kg; weight without foam: 4.2 kg. Load for buoyancy: 51.2 kg. ABS closures; EPDM sealing ring M-Class - Synthetic Rubber; automatic pressure equalization valve with ABS body and water repellent membrane - Hi-Flow Gore - TEX 3 - Mycron hydrophobic non-Woven; 8WFPP2C custom foam. Certifications: IP-67 Resistance to ingress of solid particles / water; DEF STAN 81-41 Par. 14 & 17 - Dry Heat - Temperature; IEC 60529 (IP6X) Par 13.4 & 13.6 - Protection against ingress of solids; IEC 60529 (IPX7) Par. 14.2.7 - Immersion; DEF STAN 81-41 Part ¾ Par. 21 - Low temperature; DEF STAN 81-41 Part ¾ Par. 24 - Vibration.

2.2.2.4. Gas regulator

Purpose: device for controlling of gas flow and pressure in sampling operations.

Description: gas regulator; anodized aluminum body; pressure gauges at inlet and outlet ranged to 300 bar with calibration certificate. Piston and other inner parts made by stainless steel AISI 316; incoming connection SAWM # 20 - CGA 180; scaled exit nozzle 3/16" aluminum to plastic hose; maximum



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input: 3000 psi, calibrated output pressure: 50 psi; flow set points: 0.2 / 0.3 / 0.5 / 1.0 / 1.5 / 2.0 / 3.0 / 5.0 / 8.0 l/min; working temperature -20 to 70 oC.

2.2.2.5. Drum-type (wet-test) gas meter

Purpose: gas meters are used to measure the volume of gas required for the determination of hydrogen sulfide by potentiometry or iodometry. Standard Test Method: ASTM D1071.

Description: Calibrated drum-type (wet-test) gas meter. Reading in liters; in accordance with ASTM D1071; accuracy: $\pm 2\%$ or better at standard flow and $\pm 0.5\%$ across the full measure; operating pressure range of 0 to 10 kPa to 10 kPa; measurement range from 10 l/h to 600 l/h; portable equipment; exclusively mechanical operation (no electrical power except for batteries for digital thermometer); with thermometer and water manometer; the thermometer shall have a measuring range of 0 °C to at least 50 °C; the scale intervals shall be not less than 0,5 °C; liquid level indicator; bubble level indicator and adjustable level screw.

Temperature calibration points: 15, 20, 25 and 30 ° C.

Volume calibration points: 100, 170, 230, 340, 400, 510 liters.

2.2.2.6. Karl Fischer coulometer

Purpose: equipment used to determine water in crude oil or in triethyleneglycol (TEG) by Coulometric Karl Fischer titration.

Standard Test Method: ASTM D4928 (oil) and ASTM E1064-05 (TEG).

Description: Calibrated Karl Fischer Coulometer. Set consists of: coulometric titrator, reagent automatic exchanger, magnetic stirrer; generator electrode with diaphragm, double platinum wire electrode, titration vessel. Plug & play sensors; touchscreen display. Complete set of accessories necessary for fast and precise water content determination. Power supply: 240 VAC, 50/60 Hz.

Perform the calibration of the indication of the measuring output signals of the instrument following factory procedures.

2.2.2.7. Dew point tester

Purpose: Water vapor content of gaseous fuels by measurement of dew-point temperature

Standard Test Method: ASTM D5454.

Description:

PM880 PORTABLE MOISTURE ANALYZER 5000 psig

Model PM880PKG-1-2-KIT/B

Includes:

PM880-1-1-1-0-0

Model: PM880 Portable Hygrometer; handheld hygrometer with multi-site capability; NEMA 4X/IP67; alpha-numeric/graphical backlit LCD display; battery powered; internal data logger; includes protective boot, and a soft carry case

1- Package: CSA NRTL/Baseefa certified intrinsically safe

1-Power: 115 VAC operating voltage / line cord for battery charger



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- 1- Software: Standard instrument software
- 0- Miscellaneous: None
- 0- Special: None

MISP2-2-W-T-5-0-1-0-0-0

MISP2- Microprocessor based Moisture Image Series Probe with thin film aluminum oxide moisture sensor, non- volatile calibration data storage, BASSEFA certified II 1 G EEx ia IIC T4 (Tamb=80 Deg C) and CSA C-US certified for Class I, Division 1, Groups A,B,C&D T4 when connected to IS certified hygrometer

2- Mount: 3/4 inch straight thread process connection with o-ring seal.

W- Shield: Sheet stainless steel end cap shield

T- Temperature Thermistor On Probe: Process Temperature Thermistor

5- Pressure Transducer On Probe: 500 to 5000 PSIG pressure transducer

0- Calibration Range: Standard calibration, -80 to +10 C dew/frost point.

Data from -110 to +20 C dew/frost point.

1- Calibration Certification: NIST

0- Laboratory Services: Laboratory Services – None

0- Base: CRN Labeling – None

0- Special: NONE

SPECIAL SAMPLE SYSTEM SAMP_SYS_AIOx-C-279723

Model: Sample system for aluminum oxide moisture sensor

Application: Designed to meet the sampling requirements dictated by the customer's application.

Description: Portable Sample System similar to SS880A-0-0-0-0, however all components rated >or= 5000 PSIG pressure * CPO: CPO Number: 279723

704-820 Standard 10-foot probe cable for use between TF moisture probe and PM880 Hygrometer

704-819 Standard 10-foot probe cable for use between M-Series moisture probe and PM880 Hygrometer

Misc_Item_1 SAP part number TBD- Pressure Regulator Inlet 6000 PSIG / Outlet 0 to 1500 PSIG *SS316 wetted parts

443-203 Armoured flowmeter assy, 4000 psig, 1.3 to 13 SCFH/36 to 360 SLPH, 316L SS, 1/4" compression fittings*

750-492 Pkg (5 off) replacement filter elements for 190 filter coalesce

234-050 IRDA communication cable with USB connector for PC to PT878 and PM880 communications

705-1811-00 - 6ft SS 2m Braided 6000 PSIG rated Hose

2.2.2.8. Detector tube pump

Purpose: equipment used to draw fixed volume of gas.

Standard Test Method: ASTM 4810.

Description: Hand-operated pump of a piston or bellows type. It must be capable of drawing 50 or 100 cm³ per stroke of sample through the detector tube with a volume tolerance of ± 5 cm³. It must be specifically designed for use with detector tubes. Inlet filter to protect the shaft from particulates.

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Handle houses an end-of-flow indicator. Built-in counter to keep track of the number of strokes.

2.2.3. Injection water system**2.2.3.1. Particle counter**

Purpose: Particle counter is used to measure the size and particle number concentration of particles suspended in injection water."

Standard Test Method: ISO 21501-3.

Description: Calibrated particle counter. It shall allow user-adjustable measurement using a laser sensor in the range of 3 to 100 micrometers, or wider, with at least eight channels of free-choice particle sizes. Sensor based on the principle of laser light extinction measurement (light blocking), with the following characteristics: measuring range from 3.0 to 100.0 μm or greater; maximum concentration of 10000 particles/mL for a coincidence error $<10\%$, or better. Sampling system integrated with the equipment, with magnetic stirring (optional integrated magnetic stirrer). The sampler must not be a module separate from the counter. Automatic injection and adjustable sample volume. It shall ensure reliable results with sample volumes less than 100 mL for performing the rinsing process, and at least two counts. Memory battery with automatic setup recording system. Printer integrated or external to the output printing equipment. Integrated display or interface with computer. In case of need of computer use, the same must be provided, along with the software necessary for the operation of the application. Minimum communication interface via USB or RS232 interface (in case of need of specific software to download data, this must be provided). Power supply: bivolt 110-240V, 50-60 Hz AC. It must not weigh more than 15 ± 1 kg. Supplied with a complete set of accessories necessary for particle counting in water. Calibration according to ISO 21501-3

2.2.4. Produced and discharged water system**2.2.4.1. VIS Spectrophotometer**

Purpose: Spectrophotometer is used to determine the amount of oil and grease in produced water and, additionally, nitrate and sulphate in water.

Standard Test Method: API RP45 (oil and grease), Standard Methods 4500 - NO_2^- -B (nitrite) and USEPA method 375.4 (sulphate).

Description: Calibrated benchtop spectrophotometer. Wavelength range: 400 to 900 nm; accuracy: ± 1.5 nm; resolution 1 nm. Photometric linearity ± 0.005 A. Optical path cells from 10 to 50 mm and adapters. Power module to operate the instrument online power (100-240Vac, 50/60 Hz).

2.2.4.2. Oil-in-Water Analyzer

Purpose: Oil-in-Water Analyzer is used to determine the amount of oil and grease in produced water.

Standard Test Method: ASTM D8193.



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Description: Calibrated portable oil-in-water analyzer designed to measure solvent extractable material (hydrocarbons and oil and grease) by infrared determination in water in compliance with ASTM D8193. Measurement principle: non-dispersive infrared spectroscopy from 1370-1380 cm^{-1} ; detected feature: CH_3 deformation band of hydrocarbon; extraction method: external liquid-liquid extraction with Cyclohexane; measurement time: 5 min (including background measurement); measurement range: up to 1000 mg/L oil-in-water; limit of detection: 0.5 mg/L oil-in-water; repeatability: 0 – 70 mg/L \pm 0.35 mg/L; resolution: 0.1 mg/L; display: color touchscreen; internal memory for about 100000 measurements; interfaces: built-in PC with Ethernet, USB and RS232 interfaces direct LIMS connectivity via LAN and output to printer or PC; optional input by external keyboard, mouse and barcode reader; power requirements: auto-switching 85- 264V AC, 47 63 Hz, 120 W (built in multi voltage power supply). The device software must support the automatic calculation of correlation coefficients with another oil in water methods (e.g. EPA 1664). Accessories: sampling tube with luer connector; mesh inlet filter 80 μm (5 pcs, 1 already inside sample inlet); outlet tube; waste container; power cable; protective film for touch display (5 pcs, 1 already on display); instruction manual (as PDF file on USB memory stick); micro syringe (250 μL); Gas tight syringe (20 mL); Volumetric flask (50 mL) with glass stopper.

2.2.5. Potable Water System

2.2.5.1. Turbidimeter

Purpose: Turbidimeter is used to measure turbidity in water.

Standard Test Method: Standard Methods 2130 B

Description: Calibrated portable turbidimeter; range: 0-1000 NTU. Resolution: 0.01 NTU. Repeatability: \pm 1 % of reading or 0.01 NTU, whichever is greater. Accuracy: \pm 2 % of reading. Primary calibration standards in sealed vials. Sample cells with screw-tops. Power module to operate the instrument online power (100-240 Vac, 50/60 HZ).

2.2.5.2. Color of water test

Purpose: Color water set is used to measure apparent color in water by visual comparison method.


Standard Test Method: Standard Methods 2120 B

Description: Color of water set. Calibrated color of water disc: 0-30 CU (0 / 2.5 / 5 / 7.5 / 10 / 15 / 20 / 25 / 30). Set of two Nessler tubes (250 mm) with glass plungers to eliminate distracting meniscus curvatures. Long path lengths, integrated prism; simple one button press operation (the light is on only when you need it to be).

2.2.5.3. Bench digital pH-meter

Purpose: Instrument used to pH measurements of aqueous solutions.

Standard Test Method: ASTM D1293.

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<p>Description: Calibrated bench digital pH-meter. pH range 0-14. Resolution 0.01 unit; with stirrer plate and glass electrode probe. Power module to operate the instrument online power (100-240Vac, 50/60 Hz).</p>			
<p>2.2.6. Hydraulic control fluid system</p>			
<p>2.2.6.1. Fluid Cleanliness Monitor</p>			
<p>Purpose: Determination of the particulate contamination level of the fluids. Standard Test Method: ISO 21018-3.</p>			
<p>Description: Fluid Cleanliness Monitor to monitor particulate contamination level in mineral, synthetic, or water-based fluids using the mesh blockage technique. Mesh blockage system for 4, 6 and 14 μm sizes with pressure and flow sensors. It must meet report 3-part ISO 4406, AS 4059 Table 1 (NAS 1638) or AS 4059 Table 2 cleanliness codes. Sampling system integrated with the equipment (the sampler must not be a module separate from the counter). Portable, for bench and field measurements. Integrated display. Attached or external printer. Power supply: 100-230 V AC / 50-60 Hz. Calibration according to procedures validated by the manufacturer and verification according to ISO 21018-3.</p>			
<p>2.2.7. General use equipment</p>			
<p>2.2.7.1. Conductivity meter</p>			
<p>Purpose: water conductivity monitoring. Standard Test Method: ASTM D1125.</p>			
<p>Description: Calibrated conductivity meter for aqueous and alcoholic solutions; accompanies conductivity cell $k = 1 \text{ cm}^{-1}$, thermocouples, with articulated support; conductivity standard solution (1,412$\mu\text{S/cm}$, 250 ml bottle); range: 0.01 to 2 $\mu\text{S/cm}$. Resolution selection (1 / 0.1 / 0.01 / 0.001); automatic temperature compensation from 0 to 100 $^{\circ}\text{C}$; automatic calibration; automatic check for cell; maximum and minimum alarms; LCD indicator. Power module to operate the instrument online power (100-240Vac, 50/60 Hz).</p>			
<p>2.2.7.2. Digital stopwatch</p>			
<p>Purpose: Stopwatch is used to measure the holding time of an analysis step.</p>			
<p>Description: Calibrated progressive chronometer with split, clock, alarm and calendar functions; battery driven.</p>			
<p>2.2.7.3. Ultrapure water generator</p>			
<p>Purpose: The equipment is used to produce ultrapure water for analysis. Standard Test Method: ASTM D1193 - Standard Specification for Reagent Water</p>			
<p>Description: Single device for production of reagent Type I water, conform to the requirements of ASTM 1193. Production flow rate 2 L/min; Power supply: 100-250 V, 60 Hz. Polyethylene tank larger than 5 liters. Cartridge filter set shall be supplied with the equipment. Polypropylene charcoal cartridge filter</p>			

set shall be supplied and installed on the supply line of the Ultrapure Water Generator, preferably under the bench, to accomplish water specifications. It must achieve the ultrapure water generator's requirements for the water supply line.

Note: It must be supplied with potable properly filtered water from fixed installation.

2.2.7.4. Hotplate

Purpose: Hotplates are used to heat samples.

Description: Magnetic stirrer with heating; 15 liters (water) capacity; ceramic plate; temperature range: 50°C to 550°C; speed range: 100 to 1500 rpm; LCD temperature setting; plate dimensions: 280 x 280 mm; heating power: 1.5 kW; power supply: 220V / 60 Hz.

2.2.7.5. Refrigerator

Purpose: aqueous samples storage.

Description: Refrigerator 120 L; power supply: 220 Vac 60 Hz."

2.2.7.6. Explosion-safe refrigerator

Purpose: oil samples and flammable reagents storage

Description: Explosion-proof interior Laboratory Refrigerator with approximately 600 liters capacity. Laboratory Refrigerator shall fulfill comply with EN/IEC 60079-15, for use in Category 3, Zone 2 locations where explosive gas atmospheres may be present and guarantee that the interior is free of ignition sources. Material combinations on the inside shall be non-combustible. Automatic defrosting. Temperature range: 1 to 12 °C. Microprocessor controlled temperature. Power supply: 220 VAC 60 Hz

2.2.7.7. Ice machine

Purpose: ice production to cool produced water samples in order to deliver to onshore laboratories.

Description: Stainless steel; minimum production: 50 kg / 24h at 27 oC; containing capacity at least 6 kg; 220 Vac 60 Hz.

2.2.7.8. Benchtop extraction arm

Purpose: It is used for extraction of hazardous contaminants from Micro Gas Chromatography (GC) natural gas analyzer (2.2.2.1) and hot air oven (2.2.2.2). It shall be installed over bench for chromatography.

Description: Mechanical exhaust system with independent airflow between 50 and 110 m³/h. Simultaneous and continuous operation.

2.2.7.9. Fume hood for inorganics

Purpose: Fume hood is used for safe handling of volatile compounds.

Standard Test Method: ANSI/ASHRAE 110



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Description: Variable Air Volume (VAV) hood. Made of naval plywood with fire-resistant insulation externally coated with fire-retardant high-pressure melamine laminated 1,3 mm thick; modular model; upper access to allow maintenance. AISI 316L stainless steel bench internal lining and baffles.

Explosion, vapor and gas proof luminaires with safety glass at least 4 mm thick providing 750 lux on bench. It shall have vats of a minimum size of 200 mm in diameter and 150 mm in depth, provided with drainage adequate to the fluids used. Drain shall be interconnected to the oil drain of the platform and shall not be pressurized. Conjugated vertical and horizontal driving opening door of a guillotine type, holding by counterbalance weight, with vertical opening of 600 mm and six horizontal sliding divisions made of laminated safety fire resistant glass. The equipment must be supplied with the following utilities: nitrogen gas and fresh potable water. The valves of the utility lines used in the fume hood must be located on the outside, in an easily accessible position and duly identified by color and plaque / label. All accessories in the utility lines (filters, heaters, etc.) shall be on the outside of the fume hoods. Four 220 V sockets shall be provided in the outer structure of the fume hood so as not to compromise or restrict its use. There should be no outlets inside the fume hood. Cabinet under hood shall be provided with exhaust systems and shall be fitted with three AISI 316L shelves with a containment system against spills. These cabinets must have a key system that prevents unauthorized access.

The hood shall be provided with flow rate monitors and alarms to signal failure or low speed in the exhaust system. It and shall be supplied with a local test certificate with face speed measurement and smoke test according to ANSI / ASHRAE 110 standard. Hood exhaust fan must be outside the laboratory, in an external area. Excessive noise shall be avoided in order to comply with maximum allowable noise requirements

2.2.7.10. Fume hoods for organics

Description: The specification is the same specification as the fume hood for inorganics. ~~, however, the fume hood for organic analyzes located next to the hood for organic analysis (2.2.7.12) should have a faucet attached to the kerosene line.~~

2.2.7.11. Hood for organic analysis

Description: It shall have both sides closed with laminated glass. Exhaust system and independent mechanical ventilation, with reserve equipment (2x100%). Continuous operation. With three points of illumination. Vertical and horizontal driving laminated glass window holding by counterbalance weight.

2.2.7.12. Flammable storage cabinet

Description: Flammable safety cabinet with an all-welded steel body with reinforced double walls. 1-1/2" insulating air space on top, bottom, back, sides, and doors. 2" vent with fire baffle and cap. All doors on safety cabinets shall be self-latching for secure closure. Three-point key lock system with button latches and keys for access control. Tri-lingual warning labels. 2" raised front sill prevents leaks. Galvanized Steel shelves shall hold up to 350 lbs and be provided with containment trays on the shelves for the



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storage of flammable chemicals. Cabinet shall have 4" adjustable legs to allow positioning over a vent and offer protection from ground moisture. Raised legs to allow forklift access. All steel cabinets shall meet NFPA Code 30 specifications and OSHA requirements.

2.2.7.13. Bench wise

Approximate description: jaw width: 4"(10.2 cm); jaw Opening: 4"(10.2 cm); throat depth: 2-1/5"(5.5 cm); anvil size: 2.6 X 3.1"(6.5x8 cm); clamp force: 3200 lbs; 360-degree swivel base with dual lock-down nuts; replaceable microgroove tooth steel jaws.

2.2.7.14. Gas Cylinder Cabinet

Purpose: One of these cabinets shall contain the helium gas supply systems to be provided for the Portable micro GC natural gas analyzer (item 2.2.2.1). The other one shall contain the standard calibrating gas supply systems to be provided for the Portable micro GC natural gas analyzer. The third one shall contain the nitrogen gas supply systems to be provided for the fume hoods.

Description: Painted galvanized steel ventilated cabinets, industrial type, with padlock, containing two industrial cylinders type T (50 L) or equivalent each. Two panels with pressure regulating valve and the two manifolds, for the different gases, shall be installed inside the cabinet. The installation of the cylinders must be located outside, under cover with geometry that does not allow the accumulation of gases and protects the area against bad weather. This area must be segregated from the unit's gas area and have a device for fixing the cylinders, preferably individually. A ramp for cargo handling shall be installed in front of the cabinets' door in order to allow transit of carts. These systems shall be equipped with a panel with pressure regulating valve and changeover manifold, with simultaneous connection of two cylinders (one in use and one in standby) to allow the exchange without discontinuing the gas supply in the line. Manifolds shall be placed unobstructed in a height between 1000 mm and 1600 mm from the floor where the cylinders are located for proper visualization. The doors of the cabinet shall allow easy checking of the panels without needing to open the doors. It is required to be installed another panel with pressure regulating valve inside the Laboratory, located at the chromatography area. The display of its panel shall be facing forward for easy checking.

2.2.7.15. External Cabinet

External cabinet painted galvanized steel made, industrial type, with weather protection and opening for natural ventilation, with adjustable shelves for storing sample boxes, sampling kits and sampling flasks, with containment trays, door lock with key.

3. Laboratory Equipment Tables
Table 1 – Laboratory Equipment

Item	Equipment	QTY.	Localization	Approximate dimensions (mm)		
				Width	Depth	Height
2.2.1.1	Water bath	1	Organic bench. Next to the sink and under the hood	400	600	500
2.2.1.2	Oil Test centrifuge	2	Organic bench. Next to the sink and under the hood. One in use, one spare	700	750	485
2.2.1.3	Digital thermometer	1	Cabinet	210	100	50
2.2.1.4	Salt in crude analyzer	2	Fume Hood for Organics. One in use, one spare	110	330	110
2.2.1.5	Digital density meter	1	Fume Hood for Organics or central bench	350	550	400
2.2.1.6	Potentiometric titrator	2	Fume Hood for Organics. One in use, one spare	400	400	600
2.2.1.7	Vapor pressure tester	1	Central bench	350	400	400
2.2.1.8	Cylinders for pressurized oil sampling	30	External area	330	1000	250
2.2.2.1	Portable micro GC natural gas analyzer	1	Chromatograph bench	550	410	300
2.2.2.2	Explosion-proof hot air oven	1	Chromatograph bench	600	700	600
2.2.2.3	Cylinders for gas sampling	30	External area	735	230	430
2.2.2.4	Gas regulator	6	Cabinet	100	130	110
2.2.2.5	Drum-type (wet-test) gas meter	4	Sampling point (out of the laboratory)	500	400	600
2.2.2.6	Karl Fischer coulometer	2	Fume Hood for Organics or central bench. One in use, one spare	400	400	300
2.2.2.7	Dew point tester	1	Cabinet	200	250	80
2.2.2.8	Detector tube pump	2	Cabinet. One in use, one spare	250	150	100

Table 2 – Laboratory Equipment

Item	Equipment	QTY.	Localization	Approximate dimensions (mm)		
				Width	Depth	Height
2.2.3.1	Particle counter for water injection	1	Central bench	600	700	480
2.2.4.1	VIS Spectrophotometer	1	Fume hood for inorganics	400	260	150
2.2.4.2	Oil-in-Water Analyzer	2	Fume hood for organics	350	400	400
2.2.5.1	Turbidimeter	1	Central bench	290	420	200
2.2.5.2	Color of water test	1	Central bench	200	200	350
2.2.5.3	Bench digital pH-meter	1	Central bench	400	170	190
2.2.6.1	Fluid Cleanliness Monitor	2	Central bench. One in use, one spare	400	300	300
2.2.7.1	Conductivity meter	1	Central bench	200	170	200
2.2.7.2	Digital stopwatch	1	Drawer	70	60	20
2.2.7.3	Ultrapure water generator	1	Inorganic bench	540	420	290
2.2.7.4	Hotplate	1	Fume hood for inorganics	250	350	110

Table 3 – Laboratory Equipment

Item	Equipment	QTY.	Localization	Approximate dimensions (mm)		
				Width	Depth	Height
2.2.7.5	Refrigerator	1	Office floor	600	600	700
2.2.7.6	Explosion-safe refrigerator	1	Laboratory room (on the floor)	695	870	2010
2.2.7.7	Ice machine	1	Inorganic bench	470	570	600
2.2.7.8	Benchtop extraction arm	1	Chromatograph bench	N.A.	N.A.	N.A.
2.2.7.9	Fume hood for inorganics	1	Next to the inorganic bench	2000	800	N.A.
2.2.7.10	Fume hood for organics	2	Next to Organic bench	2000	800	N.A.
2.2.7.11	Hood for organic analysis	1	Organic bench	N.A.	N.A.	N.A.
2.2.7.12	Flammable liquid storage cabinet	2	External area	1000	450	2000
2.2.7.13	Bench wise	1	Chromatograph bench	150	300	150
2.2.7.14	Gas Cylinder Cabinet	3	External area	1100	600	2100
2.2.7.15	External Cabinet	1	External area	2000	600	2100

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4. MISCELLANEOUS

4.1. Electrical panels shall not be installed close to chemical cabinets.

4.2. The water that supplies the laboratory shall come from the potable water system, serving the fume hoods (organic and inorganic), sinks, emergency shower and eye-washers.

4.3. There shall be provided a cartridge-type filtering set with double stage, composed of filter and activated carbon, with proper access for maintenance.

4.4. The cartridge-type filtering set (4.3) shall be installed inside the laboratory, but upstream of all the water piping in that environment, including Ultrapure Water Generator, sinks, Fume Hoods, eye-washers and emergency shower so that all water points use filtered water, which prevents clogging of the fume hoods piping, sinks, eye-washers and shower.

4.5. The laboratory shall have a stainless steel emergency shower located in an internal area, unobstructed, preferably in front of the entrance and exit door of the laboratory analysis room. Activated by a handle, with sieve in 316L stainless steel, diameter 250 mm and galvanized pipe, worked by lever fastened on the access door of the Laboratory, located over a recessed drainage box. There shall be no electrical installations in the shower area. The installation of this equipment shall meet the requirements of ABNT NBR 16291. The location of the emergency shower shall have a drainage box, on recessed floor (height 40 mm to 50 mm) with a siphoned drain, with the installation of a platform (in 316L stainless steel) on the same level as the finished floor, avoiding depressions or protuberances. The drainage box shall be connected to the sewage system for the Laboratory, according to its flow.

4.6 The laboratory shall have plastic ABS eye washers to be installed in bench tops, close to each sink, with hose of high pressure, length of 1800 mm and connection 1/2" NPT. Proper to be used to wash eye, face and body. Triggered through 316L stainless steel trigger valve, with green ABS plastic nozzle. High-pressure hose with 1800 mm of length and ABS plastic connection 1/2" NPT. The installation of these equipment shall comply with the requirements of ABNT NBR 16291.

4.7 All sinks shall be provided with a 316L stainless steel peg-board/drainage for glassware with polypropylene pegs, with 24 pins and drainage system.

4.8. The laboratory drains shall be interconnected in a single outlet collector and characterized as open hydrocarbon drainage in an unclassified area.

4.9. All drainage pipes shall be made of corrosion and hydrocarbon resistant material, including the siphon on the sinks, joints and seals.



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4.10. All taps shall be coated with epoxy polymer resistant to all chemical agents handled in foreseen laboratory routines.

4.11. There shall be an external place for storing cases with cylinders for sampling of natural gas and pressurized oil. The area shall be dimensioned to store at least 32 cases, considering a maximum stacking of 5 units.

4.12. All cabinets shall have nameplates identifying their specific use.

4.13. In the case of supplying a hot air oven for heating cylinders, a dedicated exhaust duct must be installed at the air outlet of the oven.