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INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	REVISED WHERE INDICATED

	REV. 0	REV. A							
DATE	SEP/09/22	OCT/31/22							
DESIGN	ESUP	ESUP							
EXECUTION	CL33	CL33							
CHECK	U4QR	U4QR							
APPROVAL	UQBE	UQBE							

TABLE OF CONTENTS

1 OBJECTIVE

1.1 This specification establishes the document S-740 – SPECIFICATION FOR BATTERIES (IEC) attached below as general requirements for batteries in offshore units.

Specification-for-Batteries-S-740v2020-1

1.2 This specification establishes additional technical requirements for design, manufacture, and supply electrical batteries for PETROBRAS Offshore Units, including installations in modules and packages that shall prevail in case of conflict or lack of information in the document S-740 – SPECIFICATION FOR BATTERIES (IEC).

1.3 Classification Society requirements shall prevail over requirements of this document.

1.4 Batteries shall be stationary-use type. This specification does not apply to batteries for engine starting and cranking applications.

2 ADDITIONAL REFERENCE STANDARDS

2.1 GENERAL

2.1.1 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

IEEE std1106	IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications

2.1.2 UNDERWRITERS LABORATORIES

UL 94	Plastics Flammability Standard

2.1.3 DEUTSCHES INSTITUT FÜR NORMUNG

DIN 40736-1	Lead Acid Batteries – Part 1: Stationary vented cells with positive tubular plates in plastic-containers

2.1.4 NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 110	Standard for Emergency and Standby Power Systems

2.2 ADDITIONAL REFERENCE STANDARDS FOR BATTERIES MANUFACTURED IN BRAZIL

2.2.1 ABNT – ASSOCIAÇÃO BRASILEIRA DE NORMALIZAÇÃO TÉCNICA

ABNT NBR 14197	Acumulador Chumbo-Ácido Estacionário Ventilado - Especificação
ABNT NBR 14198	Acumulador Chumbo-Ácido Estacionário Ventilado - Terminologia
ABNT NBR 14199	Acumulador Chumbo-Ácido Estacionário Ventilado - Ensaios
ABNT NBR 14201	Acumulador Alcalino de Níquel-Cádmio Estacionário - Especificação
ABNT NBR 14202	Acumulador Alcalino de Níquel-Cádmio Estacionário - Ensaios

ABNT NBR 14203	Acumulador Alcalino de Níquel-Cádmio Estacionário - Terminologia
ABNT NRB 14204	Acumulador Chumbo-Ácido Estacionário Regulado por Válvula - Especificação
ABNT NBR 14205	Acumulador Chumbo-Ácido Estacionário Regulado por Válvula - Ensaios
ABNT NBR 14206	Acumulador Chumbo-Ácido Estacionário Regulado por Válvula – Terminologia
ABNT NBR 16716	Baterias estacionárias - Diretrizes para projetos e requisitos para instalação em plataformas marítimas de petróleo e gás

3 REFERENCE DOCUMENTS

[1] I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS

[2] I-ET-3010.00-5140-773-P4X-001 - SPECIFICATION FOR D.C. UPS FOR OFFSHORE UNITS

[3] I-ET-3010.00-5140-773-P4X-003 - SPECIFICATION FOR A.C. UPS FOR OFFSHORE UNITS

[4] I-ET-3010.00-5140-773-P4X-002 - SPECIFICATION FOR GENERIC D.C. UPS FOR OFFSHORE UNITS

[5] ELECTRICAL SYSTEM DESCRIPTIVE MEMORANDUM

[6] I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA SHEET MODELS

[7] EMERGENCY LOADS LIST

[8] DR-ENGP-M-I-1.3 - SAFETY ENGINEERING

Note**:** Documents without code in the list are documents with variations according to project characteristics. Verify in project documentation list the reference for codes of these documents.

4 GENERAL CONDITIONS

4.1 GENERAL REQUIREMENTS

4.1.1 Batteries for A.C., D.C. and emergency lighting UPS FOR OFFSHORE UNITS shall be alkaline type nickel-cadmium or lead acid batteries for these services.

4.1.2 All General Equipment Conditions (Environmental Conditions, Heat Dissipation Characteristics, Motion and Inclination Limits Requirements, Vibration Limits Requirements, Hazardous Areas Requirements, Construction Requirements, Warning Labels for Electrical Equipment, Voltage Requirements, Frequency Requirements and EMC and RFI Requirements) not covered by this Specification, are defined, when applicable, in I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

4.1.3 The value of the short-circuit current to be indicated by supplier, shall correspond to the initial value of the current for a short-circuit in the terminals of the accumulator in the fully charged condition.

4.1.4 The number of poles of the accumulator must be dimensioned to withstand the maximum discharge current specified in the curves provided by the manufacturer.

4.1.5 For requirements related to the classification of accumulator room areas, see IEC 61892-7.

4.1.6 All plates shall be of rigid fabrication and designed to reduce to a minimum the active materials loosening and assure long life, with a minimum of maintenance, allowing a high quantity of charge and discharge cycles, without damaging the element.

4.1.7 The energized parts (poles and busbars) must be fully coated with easy-to-remove insulating material, maintaining a measuring point.

4.1.8 The screws used to connect the poles must not contain torque information different from the torque recommended in the manual. The torque recommended in the manual must be informed through a label to be installed on the accumulator.

4.1.9 Minimum spacing 10 mm must be adopted between adjacent accumulators to allow adequate cooling air flow.

4.1.10 Vessels shall have a lid made of FR material grade V0 according to UL 94 and they shall allow the visual indication of liquid electrolyte level.

4.2 LIFETIME EXPECTANCE

4.2.1 The lifetime for alkaline batteries shall be the minimum of 20 years (25 ºC). During this lifetime period, alkaline battery design shall not foresee any water replenishment.

4.2.2 Considering Lead Acid batteries, the lifetime shall be at least 10 years (25ºC) of operation, under service conditions, beginning at commissioning date. The lifetime expectance shall not be degraded due to storage time before commissioning.

4.3 BATTERIES SIZING

4.3.1 Each battery bank of redundant systems shall be sized to feed 100% of the whole load of its system for the autonomy time defined in DR-ENGP-M-I-1.3 - SAFETY ENGINEERING and EMERGENCY LOADS LIST. Unless otherwise stated in project documentation, reserve future loads shall not be included in consumer loads for batteries sizing.

4.3.2 Each battery bank shall be sized considering ageing factor of 25%.

4.3.3 Lead acid batteries shall be sized according to IEEE Std 485 and alkaline batteries shall be sized according to IEEE Std 1115.

4.3.4 For Automation and Instrumentation Panels, the circuits for internal lighting and internal sockets shall not be considered for sizing the battery banks.

4.4 BATTERY INSTALLATION

4.4.1 Racks for vented batteries shall be step-type. For valve-regulated batteries, shelf-type racks could be used.

4.4.2 Racks shall be of the step type, with only one row on each landing, so that the complete set of racks shall form a ladder, not exceeding two steps.

4.4.3 The racks shall be provided with cover to protect against flow of electrical current to ground and liquid spills.

4.4.4 Racks shall have provisions for route and fasten the interconnection cables and the incoming external cables.

4.4.5 Racks structures shall be calculated to not deform with the batteries weight accelerated by the platform/vessel motions and shall allow a precision alignment and a safe fixation of the cells.

4.4.6 All battery racks shall allow the visual indication of electrolyte levels off all batteries installed on it.

4.4.7 Racks shall be on phosphate steel and painted according to painting requirements in I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT.

4.4.8 Racks shall be grounded/bonded to structure.

4.4.9 Fixed collection trays made of stainless steel or other acid-resistant material must be provided under each battery shelf level. If plastic material is used, it must be flame retardant, grade V0 according to UL 94.

5 ALKALINE BATTERIES

5.1 Alkaline NiCd batteries manufactured in Brazil shall comply with the requirements of ABNT NBR 14201, ABNT NBR 14202 and ABNT NBR 14203.

5.2 The rated capacity for alkaline batteries, shall be based on a discharge time of 5 (five) hours (C5). The calculated rated capacity of the batteries shall be available considering new batteries and electrolyte temperature of 25ºC.

5.3 The minimum discharge voltage for alkaline batteries measured at elements terminals shall be 1.0V. The above informed voltages shall be assured at the end of the autonomy as well as during the transient phenomena due to insertion of solenoids or to motors starts.

5.4 The electrolyte must present density (specific gravity) characteristics of 1.180 g/cm^3 ±0.010 g/cm^3 @25ºC and shall present characteristics according to IEEE Std 1106.

5.5 The electrolyte shall be clear and free from suspended impurities. The maximum content of impurities allowed in the electrolyte shall be according to Table 1 below:

Table 1 - Maximum permissible impurities

IMPURITIES	DESCRIPTION	MAXIMUM PERMISSIBLE	
		FOR FILLING (g/L)	ELEMENTS CHARGED IN OPERATION (g/L)
CARBONATE,	K_2CO_3	7.50	75
CHLORIDE	KCL	0.10	0.40
SULFATE	K_2SO_4	0.80	4
NITRATE	KNO_3	0.10	0.30
SILICA	SiO_2	0.10	2
ALUMINUM	Al_2O_3	0.008	0.05
CALCIUM	CaO	0.05	0.15
MAGNESIUM	MgO	0.05	0.15
HEAVY METALS	-	0.03	0.03

5.6 Batteries with density range from 1.180 g/cm^3 to 1.210 g/cm^3 ±0.010 g/cm^3 @20ºC can be accepted if manufacturer dilute the density to 1.180 g/cm^3 ±0.010 g/cm^3 @25ºC before furnishment and confirmed during factory acceptance test.

5.7 Distilled or deionized water shall be purified by distillation or ion exchange, being clear and colorless.

5.8 Distilled or deionized water shall have a maximum conductivity of 10 µS/cm at 25ºC and a permissible PH range of 5 to 7.

5.9 The maximum concentration of impurities in distilled or deionized water must be according to Table 2 below:

Table 2 - Maximum concentration of permissible impurities

IMPURITIES	%	mg/L
EVAPORATION RESIDUE	0.001	10
OXIDIZABLE ORGANIC SUBSTANCES (EXPRESSED IN KMnO4)	0.002	20
TOTAL HALIDES SUCH AS CHLORIDES	0.0001	1
NITRATES	0.0001	10
AMMONIA	0.0005	5
MANGANESE	0.00001	0.1
COPPER	0.0001	1
IRON	0.0001	1

5.10 MATERIAL CHARACTERISTICS

5.10.1 The alkaline accumulator model is a pocket plate type in accordance with IEC 60623 (vented accumulator) or IEC 62259 (accumulator with recombination of gases).

5.10.2 The poles shall have insulated connections for easy measurement.

5.11 ELECTRICAL CHARACTERISTICS

5.11.1 The recharge efficiency of the accumulator must be such that it is 100% charged in 8 hours, for the 0.2C5 regime, in accordance with IEC 60623.

5.11.2 The discharge regime must be of medium intensity (type M according to IEC 60623).

5.11.3 The design life of the accumulator shall be greater than 20 years at 25°C.

5.11.4 The accumulators must withstand up to 15% “ripple” of current, without reducing their useful life.

5.11.5 The rated voltage of the accumulators must be as indicated in the Data Sheet.

6 VENTED LEAD ACID BATTERIES

6.1 Vented lead acid batteries manufactured in Brazil shall comply with the requirements of ABNT NBR 14197, ABNT NBR 14198 and ABNT NBR 14199.

6.2 Anti-explosion valves must be provided for lead acid accumulators.

6.3 The electrolyte must present density characteristics of 1.210 g/cm^3 ±0.010 g/cm^3 @25ºC.

6.4 Batteries with density range from 1.210 g/cm3 to 1.240 g/cm^3 ±0.010 g/cm^3 @20ºC can be accepted if manufacturer dilute the density to 1.210 g/cm^3 ±0.010 g/cm^3 @25ºC before furnishment and confirmed during factory acceptance test.

6.5 The electrolyte shall be clear and free from suspended impurities. The maximum content of impurities allowed in the electrolyte shall be according to Table 3 below:

Table 3 - Maximum permissible impurities

IMPURITIES	DESCRIPTION	MAXIMUM PERMISSIBLE			
		FOR FILLING		ELEMENTS CHARGED IN OPERATION	
IRON	Fe	%	mg/L	%	mg/L
ANHYDRIDE SULFURANT	SO_2	0.0025	30	0.0082	100
ARSENIC	As	0.0013	16	0.0013	16
ANTIMONY	Sb	0.00008	1	0.00025	3
MANGANESE	Mn	0.000016	0.20	0.000016	0.20
COPPER	Cu	0.000041	0.50	absent	absent
TIN	Sn	0.00008	1	0.00025	3
BISMUTH	Bi	0.00008	1	0.00025	3
CHROME	Cr	0.000016	0.20	0.000016	0.20
NICKEL	Ni	0.00008	1	0.00008	1
COBALT	Co	0.00008	1	0.00008	1
PLATINUM	Pt	absent	absent	absent	absent
TITANIUM	Ti	0.000016	0.20	0.000016	0.20
TOTAL HALOGENATES, AS CHLORIDES	CL^-	0.0004	5	0.0165	200
NITROGEN AS AMMONIA	NH^+	0.004	50	0.004	50
NITROGEN AS NITRATES	-	0.0008	10	0.0008	10
FIXED WASTE	-	0.02	250	0.066	800
OXIDABLE ORGANIC SUBSTANCES	$KMnO_4$	0.0025	30	0.0025	30

6.6 Distilled or deionized water shall be purified by distillation or ion exchange, being clear and colorless.

6.7 Distilled or deionized water shall have a maximum conductivity of 10 µS/cm at 25º C and a permissible PH range of 5 to 7.

6.8 The maximum concentration of impurities in distilled or deionized water must be according to Table 2 above.

6.9 MATERIAL CHARACTERISTICS

6.9.1 The lead used as raw material in the grids and in the active material shall be of high purity.

6.9.2 Lead acid batteries shall be of the OPzS type according to DIN 40736-1.

6.9.3 Spare parts for 2 years shall be provided considering an additional 10% safety filter (explosion valve).

6.9.4 For lead acid batteries, the interconnections between the accumulators must be made with flexible insulated copper cables, class 6 stranding.

6.10 ELECTRICAL CHARACTERISTICS

6.10.1 The recharge efficiency of the vented accumulator shall be such that it is minimum of 80% charged in 10 hours, for the 0.1C10 regime, in accordance with IEC61892-3.

6.10.2 The float charge regime, with current limited to 0.1C10, the accumulators shall reach 90% of the state of charge at float voltage within 24 hours.

6.10.3 The discharge regime must be of medium intensity at a reference temperature of 25ºC, in accordance with IEEE 1184.

6.10.4 Accumulators must withstand, without degradation of the useful life, up to 2A (RMS) for every 100 Ah of the C10 rated capacity and 1% of "ripple" of the float voltage.

6.10.5 The rated voltage of the accumulators shall be as indicated in the Data Sheet.

6.10.6 The remaining capacity obtained after 90 days in open circuit, at a temperature of 25 °C, cannot be less than 82% of the real capacity in the rated regime (C10).

6.10.7 The minimum discharge voltage for vented lead acid batteries measured at elements terminals shall be 1.75V. The above informed voltages shall be assured at the end of the autonomy as well as during the transient phenomena due to insertion of solenoids or to motors starts.

7 VRLA BATTERIES

7.1 VRLA type accumulators must be installed in air-conditioned rooms with a temperature between 20°C and 25°C.

7.2 The accumulator shall be designed to withstand, without degradation of its useful life, ripple voltage up to 1% (RMS) of the float voltage and in current at 2A (RMS) for every 100 Ah of the rated capacity (C10).

7.3 CABINETS

7.3.1 Cabinets shall be of the self-supporting type, in steel and dimensioned to support the total weight of the elements or monoblocks, and with electrolyte resistant paint.

7.3.2 Cabinet protection degree shall be according to data sheet and in compliance with IEC 60529.

8 ADDITIONAL REQUIREMENTS OF MARKING

8.1 Additional marking to be considered to item 10.5.2 of the document S-740 – SPECIFICATION FOR BATTERIES (IEC):

- Petróleo Brasileiro S/A - PETROBRAS

- Minimum and maximum torques of the accumulator connections;
- Initial float current and maximum load current;
- Feeding equipment TAG number (Battery charger or UPS).
- Minimum expected autonomy in hours and minutes.

8.2 Lead acid accumulators, in addition to item 8.1, shall contain the resistance, conductance and impedance value of the fully charged accumulator at 25°C.

9 QUALITY ASSURANCE

9.1 Integral warranty for 5 years shall be given to Alkaline type batteries.

9.2 Integral warranty for 3 years shall be given to Lead Acid type batteries.

10 ADDITIONAL REQUIREMENTS OF DOCUMENTATION

10.1 All drawings, instructions, data sheets, design calculations or any written information shall be furnished in both English and Portuguese languages.

10.2 Manufacturer's documentation is an integral part of the order, which shall not be considered complete until the full documentation has been delivered as required in the purchase requisition.

10.3 Documentation to be sent attached to the Proposal for Technical Analysis, shall contain, at least, the following information according to Table 4:

Table 4 - Documents for the proposal

Item	Description
1	Documents list with issue deadlines
2	List of deviations or alternatives to specifications
3	Fabrication schedule
4	Reference list of similar installations (note 1)
5	List of technical standards applicable to manufacturing and testing design
6	Warranty and conditions
7	Scope of supply
8	Sub-suppliers list
9	Materials list (note 2)
10	General arrangement (note 3)
11	Layout (note 4)
12	Equipment model and accessories performance curves
13	Equipment datasheet (note 5)
14	Batteries memory calculating (note 6)
15	Thermal dissipation (note 7)
16	Complete and detailed scheme of treatment and painting including chemical and physical performance indices
17	Center of gravity and weight
18	Battery Operation Description
19	Installation and assembly procedures
20	Unpacking and preservation procedures
21	Handling and shipping procedures
22	Pre-commissioning and commissioning procedure

Item	Description
23	Storage recommendations before and after assembly
24	List of special tools for assembly and maintenance
25	List of identification and signaling plates;
26	Recommended spare parts list for installation, commissioning and start-up (note 8)
27	Recommended spare parts list considering the entire life cycle of the equipment (note 8)
28	Quality plan
29	Inspection and test plans, indicating the applicable standards and acceptance values
30	ISO 9001 certificate of conformity
31	Factory acceptance test procedure
32	Classification Society certificates
33	Type approval certificates by the Classification Society
34	Maritime Authority certificates
35	Third party certificate with type test reports (note 9)
36	Batteries manual (note 10)

Note 1: The UPS manufacturer shall present a supply list of similar equipment with a minimum operation of 3 years.

Note 2: Catalogs of batteries and its components, containing the characteristics and technical specifications, shall be part of this document.

Note 3: The design of accumulator and its rack with dimensions, shall be part of this document.

Note 4: The general accumulators and its components distribution in rack shall be part of this document.

Note 5: The design data sheet shall be fully completed and authenticated by the manufacturer, including the fields referring to the standards applicable to the design, fabrication, and testing of the batteries.

Note 6: Sizing the batteries according with item 4.3.

Note 7: The maximum heat dissipation to the environment of the batteries and its components in the various operating possibilities with nominal load (normal mode, stored energy mode, with battery charging (deep, float and equalize).

Note 8: Manufacturer shall provide lists of tools and accessories necessary for maintenance and installation and list of recommended spare parts. Components requiring periodic replacement shall be listed in the spare parts list with the recommended replacement frequency. The list of spare parts shall be as required in the RM, with a breakdown of the respective codes ("part-number") and unit prices.

Note 9: Batteries manufacturer shall submit a copy of the Type Tests.

Note 10: Batteries manual shall comply with item 10.6.

10.4 Documents to be sent for Approval shall contain, at least, the following information according with Table 5:

Table 5 - Documents for approval

Item	Description
1	Documents list with issue deadlines
2	Fabrication schedule
3	Fabrication progress report
4	Detailed fabrication drawings
5	Reference list of similar installations (note 1)
6	List of technical standards applicable to manufacturing and testing design
7	Warranty and conditions
8	Scope of supply
9	Sub-suppliers list
10	Materials list (note 2)

Item	Description
11	Batteries technical specification
12	Nameplates drawings
13	Dimensional drawing of the shelf/battery assembly, with the type of fixing devices for the assembly to the floor
14	General arrangement (note 3)
15	Layout (note 4)
16	Equipment model and accessories performance curves
17	Equipment datasheet (note 5)
18	Batteries memory calculating (note 6)
19	Rack memory calculation
20	Thermal dissipation (note 7)
21	Equipment (model) and accessories performance curves
22	List of parts with weight more than 30 kg
23	List of components to be assembled and installed at the installation site (including charging procedure)
24	List of items provided separately
25	Connections and wiring diagrams/schemes
26	Complete and detailed scheme of treatment and painting including chemical and physical performance indices
27	Center of gravity and weight
28	Battery Operation Description
29	Installation and assembly procedures
30	Unpacking and preservation procedures
31	Handling and shipping procedures
32	Pre-commissioning and commissioning procedure
33	Storage recommendations before and after assembly
34	List of special tools for assembly and maintenance
35	List of identification and signaling plates;
36	Recommended spare parts list for installation, commissioning and start-up (note 8)
37	Recommended spare parts list considering the entire life cycle of the equipment (note 8)
38	Quality plan
39	Inspection and test plans, indicating the applicable standards and acceptance values
40	ISO 9001 certificate of conformity
41	Factory acceptance test procedure
42	Factory acceptance test report
43	Site Acceptance test
44	Instruments testing and calibration certificates
45	Training program
46	Classification Society certificates for batteries and rack
47	Type approval certificates by the Classification Society
48	Maritime Authority certificates
50	Batteries manual (note 9)

Note 1: The UPS manufacturer shall present a supply list of similar equipment with a minimum operation of 3 years.

Note 2: Catalogs of batteries and its components, containing the characteristics and technical specifications, shall be part of this document.

Note 3: The design of accumulator and its rack with dimensions, shall be part of this document.

Note 4: The general accumulators and its components distribution in rack shall be part of this document.

Note 5: The design data sheet shall be fully completed and authenticated by the manufacturer, including the fields referring to the standards applicable to the design, fabrication, and testing of the batteries.

Note 6: Sizing the batteries according with item 4.3.

Note 7: The maximum heat dissipation to the environment of the batteries and its components in the various operating possibilities with nominal load (normal mode, stored energy mode, with battery charging (deep, float and equalize).

Note 8: Manufacturer shall provide lists of tools and accessories necessary for maintenance and installation and list of recommended spare parts. Components requiring periodic replacement shall be listed in the spare parts list with the recommended replacement frequency. The list of spare parts shall be as required in the RM, with a breakdown of the respective codes ("part-number") and unit prices.

Note 9: Batteries manual shall comply with item 10.6.

10.5 Technical documentation with the data books according with Table 6:

Table 6 - Documents for data book

Item	Description
1	Documents list with issue deadlines
2	Fabrication schedule
3	Fabrication progress report
4	Detailed fabrication drawings
5	Reference list of similar installations
6	List of technical standards applicable to manufacturing and testing design
7	Warranty and conditions
8	Scope of supply
9	Sub-suppliers list
10	Materials list
11	Batteries technical specification
12	Nameplates drawings
13	Dimensional drawing of the shelf/battery assembly, with the type of fixing devices for the assembly to the floor
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33	Storage recommendations before and after assembly

Item	Description
34	List of special tools for assembly and maintenance
35	List of identification and signaling plates;
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37	Recommended spare parts list considering the entire life cycle of the equipment
38	Quality plan
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41	Factory acceptance test procedure
42	Factory acceptance test report
43	Site Acceptance test
44	Instruments testing and calibration certificates
45	Training program
46	Classification Society certificates for batteries and rack
47	Type approval certificates by the Classification Society
48	Maritime Authority certificates
50	Batteries manual

10.6 ACCUMULATOR MANUALS

10.6.1 They must contain at least the requirements of ABNT NBR 14197, NBR 14201 or NBR 14204 and complemented with what is described in 10.6.2 to 10.6.5.

10.6.2 Constructive, dimensional, and physical aspects:

a) Constructive characteristics of the accumulators: plates, separators, vessels, covers, bushings, poles, regulating valves, and other specific parts, specifying the materials used;

b) Dimensional characteristics of the accumulators: weight and external dimensions;

c) Physical characteristics of the accumulator: electrolyte density, voltage and operating temperature.

10.6.3 Performance and features:

a) capacity variation curve as a function of temperature for lead acid accumulators from 10 °C to 45 °C and alkaline accumulators from -20 °C to 55 °C;

b) Service life depending on the temperature of the accumulators (10 °C to 45 °C for lead acids or -20 °C to 55 °C for alkaline);

c) Fluctuation current of fully charged accumulators at 25°C;

d) Correction coefficient for the fluctuation voltage as a function of the temperature of the accumulators;

e) Curves of K values and experimental characteristic tables of capacity versus discharge time (in constant current and constant power regimes) and charging current versus charging time, for the several types of accumulators and discharge intensity regimes;

f) Recharge curves with voltages of fluctuation, charge and equalization, with procedures that do not imply a reduction in the useful life of alkaline accumulators and impacts on the reduction of useful life in lead acid accumulators;

g) Curves and/or tables of load state variation as a function of open circuit voltage;

h) Loss of capacity as a function of operating time;

i) Loss of capacity as a function of the number of charge and discharge cycles informing the discharge depth, recharge regime, temperature and intervals between charges and discharges;

j) Self-discharge as a function of temperature;

k) Emission of gases;

l) Chemical reactions involved;

m) Internal resistance, conductance and impedance (value and method adopted for its determination);

n) Maximum permissible ripple (ripple), in values of current and voltage in the accumulator.

10.6.4 Operation and maintenance:

a) Specific value for the float voltage according to the installation and operation conditions (medium discharge intensity);

b) Recommendations for operation under unfavorable environmental conditions;

c) Voltage, current and equalization charge time values and applicable procedures;

d) Test method for evaluating the capacity referencing the procedure adopted in the IEC and ABNT standards for lead acid accumulators and alkaline;

e) Maintenance program: procedures and frequency;

f) Curves or tables that indicate the variations of the fluctuation current as a function of the time of use of the accumulator;

g) Description of the most common abnormalities and defects related to the operation, likely to occur throughout the life of the accumulator and their probable causes, as well as the detailed procedures for their correction;

h) Safety requirements, PPE, instruments and tools necessary for the installation and preventive maintenance of the accumulator.

10.6.5 Storage, assembly, and preservation:

a) Transport, storage and installation;

b) Receiving and unpacking;

c) Storage of accumulators: characteristics of the location and maximum storage time without recharging as a function of temperature;

d) Mechanical assembly of the shelf/Cabinets; include in item 9.2 and databook;

e) Installation of accumulators;

f) Recommendation for interconnection between elements located at distinct levels on the shelf, when applicable; include in item 9.2 and databook;

g) Interconnection of accumulators at the same level; include in item 9.2 and databook;

h) Torque applicable to the interconnection screws between the accumulators and the end of the row;

i) Start-up procedure;

j) Table listing the accumulator interconnection bars according to accumulator type/code and accumulator application.

10.7 Battery data sheet template is available at I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA SHEET MODELS.

11 ADDITIONAL REQUIREMENTS OF BATTERY ACCESSORIES

11.1 All tools, accessories necessary and recommendations for maintenance, for cell handle (substitution), for electrolyte substitution and for level completion shall be provided.

11.2 Manufacturer shall provide a list of recommended spare parts. Components requiring periodic replacement shall be listed in the spare parts list with the recommended replacement frequency.

11.3 Manufacturer shall provide the necessary spare parts for the commissioning and pre operation periods.

12 ADDITIONAL REQUIREMENTS OF HANDLING, PACKING TRANSPORTATION AND STORAGE

12.1 Alkaline and lead acid valve regulated batteries shall be furnished humid charged.

12.2 All battery systems, inclusive those to be installed in modules and packages, shall be delivered at appointed construction site no more than 3 months before unit date to sail to final location.

12.3 After the maximum storage period informed by the manufacturer, if immediate start-up is not foreseen, periodic load reinforcement must be applied, according to the manufacturer's recommendations, to preserve the useful life.

12.4 The start-up of the accumulators must be carried out according to the procedure described by the manufacturer, in the presence of the manufacturer or his representative.

13 TESTING

13.1 GENERAL REQUIREMENTS

13.1.1 Lead acid and alkaline batteries manufactured in Brazil shall consider the following additional standards referring to tests that shall be executed at acceptance procedures during delivery:

- Lead acid vented batteries shall be tested according to ABNT NBR 14199.
- Lead acid valve regulated batteries shall be tested according to ABNT NBR 14205.
- Alkaline NiCad batteries shall be tested according to ABNT NBR 14202.

13.2 Battery bank shall perform with 100% of capacity. If the test is not approved, the manufacturer shall replace the battery bank by a new one.

13.3 Any non-conformity found in any test, the complete batch shall be considered rejected.

13.4 FAT and SAT tests shall be carried out on 100% of the accumulators.

13.5 Replacement of accumulators shall not be accepted during tests.

13.6 The accumulators supplied must have the same characteristics as those reported in the type tests.

13.7 Minimum FAT and SAT test list according with Table 7:

Table 7 - Minimum FAT and SAT tests

1	GENERAL TESTS FOR ALL TYPE OF BATTERIES		
ITEM	**MINIMUM TEST LIST**	**METHOD CRITERIA**	**SCHEDULE**
1	EXAMINATION OF TECHNICAL DOCUMENTATION	TECHNICAL DOCUMENTATION ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN	1-2
2	ACCURACY CERTIFICATE OF MEASUREMENT INSTRUMENTS TO BE USED IN TESTS	COMPONENT AND MANUFACTURER STANDARD	1-2
3	VISUAL AND DIMENSIONAL CHARACTERISTICS	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 1	1-2
4	STRUCTURAL AND CONSTRUCTIVE INSPECTION	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 2 and 15	1-2
5	MARKING, IDENTIFICATION, DATA ON NAMEPLATE AND SAFETY WARNINGS CHECK	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN	1-2
6	MATERIAL LIST INVENTORY CHECK	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN	1
7	CHECKING OF INTERCHANGEABLE DEVICES	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN	1
8	PAINTING (COLOUR, THICKNESS AND ADHESION)	ACCORDING WITH I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING	1
9	ELECTROLYTE ANALYSIS	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 8 and 14	1
10	VOLTAGE DROP IN INTERCONNECTIONS	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 9 and 14	1-2
11	CHEMICAL ANALYSIS OF METAL ALLOYS	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 10 and 14	3
12	IDENTIFICATION OF POLYMERIC MATERIALS	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 11 and 14	3
13	RESIDUAL STRESS DEVELOPMENT OF VESSEL AND LID MOLDING	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 12 and 14	3
14	VESSEL WATERTIGHTNESS	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 13 and 14	3
2	**TESTS FOR VENTED LEAD ACID BATTERIES**		
ITEM	**MINIMUM TEST LIST**	**METHOD CRITERIA**	**SCHEDULE**
1	MEASUREMENT OF THE OPEN CIRCUIT VOLTAGE OF EACH ACCUMULATOR	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN NOTES 3, 4 and 6	1
2	MEASUREMENT OF RESISTANCE, CONDUCTANCE, OR IMPEDANCE	ACCORDING WITH IEC IEC60896-11 AND I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN NOTES 4 AND 5	1
3	CAPACITY TEST IN RATED MODE	ACCORDING WITH IEC IEC60896-11	1-2
4	CAPACITY TEST IN DESIGN MODE	ACCORDING WITH IEC IEC60896-11	1
5	TEST OF SUITABILITY FOR BATTERY FLOATING OPERATION	ACCORDING WITH IEC IEC60896-11	1
6	ENDURANCE TEST IN DISCHARGE-CHARGE CYCLES	ACCORDING WITH IEC IEC60896-11	1
7	ENDURANCE TEST IN OVERCHARGE	ACCORDING WITH IEC IEC60896-11	1
8	CHARGE RETENTION TEST	ACCORDING WITH IEC IEC60896-11	1
9	SHORT-CIRCUIT CURRENT	ACCORDING WITH IEC IEC60896-11	1
10	PROTECTION AGAINST INTERNAL IGNITION CAUSED BY AN EXTERNAL SPARK	ACCORDING WITH I-ET-3010.00-5140-714-P4X-001 AND UPS DESIGN. NOTE 7 and 14	3

3	TESTS FOR VENTED ALKALINE NICKEL-CADMIUM BATTERIES		
ITEM	**MINIMUM TEST LIST**	**METHOD CRITERIA**	**SCHEDULE**
1	DISCHARGE	ACCORDING WITH IEC-60623	1-2
2	HIGH RATE CURRENTS	ACCORDING WITH IEC-60623	1
3	ENDURANCE IN CYCLES	ACCORDING WITH IEC-60623	3
4	CHARGE ACCEPTANCE AT CONSTANT VOLTAGE	ACCORDING WITH IEC-60623	1
5	CHARGE RETENTION	ACCORDING WITH IEC-60623	3
6	ELECTROLYTE RETENTION	ACCORDING WITH IEC-60623	1
7	STORAGE	ACCORDING WITH IEC-60623	3
8	PHYSICAL APPEARANCE	ACCORDING WITH IEC-60623	1
9	OPEN CIRCUIT VOLTAGE AND POLARITY	ACCORDING WITH IEC-60623	1
4	**TESTS FOR GAS RECOMBINATION ALKALINE NICKEL-CADMIUM BATTERIES**		
ITEM	**MINIMUM TEST LIST**	**METHOD CRITERIA**	**SCHEDULE**
1	MEASUREMENT OF THE OPEN CIRCUIT VOLTAGE OF EACH ACCUMULATOR	ACCORDING WITH IEC IEC62259	1
2	MEASUREMENT OF RESISTANCE, CONDUCTANCE, OR IMPEDANCE	ACCORDING WITH IEC IEC62259	1
3	DISCHARGE	ACCORDING WITH IEC IEC62259	1-2
4	CHARGE ACCEPTANCE AT CONSTANT VOLTAGE	ACCORDING WITH IEC IEC62259	1
5	ELECTROLYTE RETENTION	ACCORDING WITH IEC IEC62259	1
6	DETERMINATION OF GAS RECOMBINATION EFFICIENCY	ACCORDING WITH IEC IEC62259	3
7	PERMANENT CHARGE ENDURANCE	ACCORDING WITH IEC IEC62259	3
8	STORAGE	ACCORDING WITH IEC IEC62259	3
9	ENDURANCE TEST	ACCORDING WITH IEC IEC62259	3
10	CHARGE RETENTION TEST	ACCORDING WITH IEC IEC62259	3
11	SHORT-CIRCUIT CURRENT	ACCORDING WITH IEC IEC62259	3
5	**TESTS FOR VRLA BATTERIES**		
ITEM	**MINIMUM TEST LIST**	**METHOD CRITERIA**	**SCHEDULE**
1	GAS EMISSION	ACCORDING WITH IEC IEC60896-21	3
2	HIGH CURRENT TOLERANCE	ACCORDING WITH IEC IEC60896-21	1
3	SHORT CIRCUIT CURRENT AND D.C. INTERNAL RESISTANCE	ACCORDING WITH IEC IEC60896-21	1
4	PROTECTION AGAINST INTERNAL IGNITION FROM EXTERNAL	ACCORDING WITH IEC IEC60896-21	1
5	SPARK SOURCES	ACCORDING WITH IEC IEC60896-21	3
6	PROTECTION AGAINST GROUND SHORT PROPENSITY	ACCORDING WITH IEC IEC60896-21	3
7	CONTENT AND DURABILITY OF REQUIRED MARKINGS	ACCORDING WITH IEC IEC60896-21	3
8	MATERIAL IDENTIFICATION	ACCORDING WITH IEC IEC60896-21	1
9	VALVE OPERATIONS	ACCORDING WITH IEC IEC60896-21	1
10	FLAMMABILITY RATING OF MATERIALS	ACCORDING WITH IEC IEC60896-21	1
11	INTERCELL CONNECTOR PERFORMANCE	ACCORDING WITH IEC IEC60896-21	1-2
12	DISCHARGE CAPACITY	ACCORDING WITH IEC IEC60896-21	1-2
13	CHARGE RETENTION DURING STORAGE	ACCORDING WITH IEC IEC60896-21	3
14	FLOAT SERVICE WITH DAILY DISCHARGES	ACCORDING WITH IEC IEC60896-21	3
15	RECHARGE BEHAVIOUR	ACCORDING WITH IEC IEC60896-21	3
16	SERVICE LIFE AT AN OPERATING TEMPERATURE OF 40 °C	ACCORDING WITH IEC IEC60896-21	3
17	IMPACT OF A STRESS TEMPERATURE OF 55 °C OR 60 °C	ACCORDING WITH IEC IEC60896-21	3
18	ABUSIVE OVER-DISCHARGE	ACCORDING WITH IEC IEC60896-21	3
19	THERMAL RUNAWAY SENSITIVITY	ACCORDING WITH IEC IEC60896-21	3

20	LOW TEMPERATURE SENSITIVITY	ACCORDING WITH IEC IEC60896-21	3
21	DIMENSIONAL STABILITY AT ELEVATED INTERNAL PRESSURE AND TEMPERATURE	ACCORDING WITH IEC IEC60896-21	3
22	STABILITY AGAINST MECHANICAL ABUSE OF UNITS DURING INSTALLATION	ACCORDING WITH IEC IEC60896-21	3
23	SERVICE LIFE AT AN OPERATING TEMPERATURE OF 40 °C	ACCORDING WITH IEC IEC60896-21	3
24	IMPACT OF A STRESS TEMPERATURE OF 55 °C OR 60 °C	ACCORDING WITH IEC IEC60896-21	3
25	ABUSIVE OVER-DISCHARGE	ACCORDING WITH IEC IEC60896-21	3
26	THERMAL RUNAWAY SENSITIVITY	ACCORDING WITH IEC IEC60896-21	3
27	LOW TEMPERATURE SENSITIVITY	ACCORDING WITH IEC IEC60896-21	3
28	DIMENSIONAL STABILITY AT ELEVATED INTERNAL PRESSURE AND TEMPERATURE	ACCORDING WITH IEC IEC60896-21	3
29	STABILITY AGAINST MECHANICAL ABUSE OF UNITS DURING INSTALLATION	ACCORDING WITH IEC IEC60896-21	3

SCHEDULE OF EXECUTION

1 - Carry Out during Factory Acceptance Test (FAT)

2 - Carry Out during Site Acceptance Test (SAT)

3 - Accept type test report if conformity test, approved by third part entity, recognized both by Manufacturer, PETROBRAS, and classification society, was made on same serial product.

GENERAL NOTES

Note 1: Typical execution and acceptance criteria:

a) Correct assembly of poles
b) Identification of elements and battery pack;
c) The poles shall be aligned, without casting flaws or presence of burrs;
d) The drilling of the poles must allow the perfect alignment of the interconnections and be compatible with the screws to be used;
e) The surface finish of screws, nuts and interconnects must be uniform;
f) The vessel must allow the internal visualization of the accumulator components and be clean, uniform in color, without burrs, cracks, breaks and gross scratches on the sides;
g) The vessel, when exposed to a flat surface, must be level;
h) The cover must be clean, uniform in color, without burrs, cracks, breaks, gross scratches and signs of burning;
i) The sealing of the cap/vessel junction must be uniform and continuous;
j) There must be no leakage of solution at any point of the cap-vessel, cap-pole and safety filter cap junctions;
k) There is an indelible marking for checking the maximum and minimum electrolyte levels and the electrolyte level is between the maximum and minimum marks;
l) The set of plates is intact, without deformations, exaggerated distances between plates and if it is correctly assembled;
m) There is no excess sedimentation and there are no foreign bodies inside the vessel;
n) There is space inside the vessel for sedimentation of active material during the life of the element.

Note 2: Dimensions of the elements with a tolerance of ± 2%, limited to 5mm.

Note 3: It shall be between 2.08V to 2.10V for vented accumulators and 2.12V to 2.18V for VRLA accumulators.

Note 4: Shall be take place before starting the discharge process.

Note 5: The maximum dispersion of this measurement must be less than ± 5 % of the average value of the measurements.

Note 6: After finishing the charge, wait a minimum of 4 hours and a maximum of 24 hours.

Note 7: Tests of anti-explosion valves confirming that external sparks do not cause internal ignition.

Note 8: Collect electrolyte sample and determine the level of impurities present.

a) Accumulators in full charge condition;

b) Density at temperature and with values as defined in item 5.3 for alkaline nickel-cadmium batteries and items 6.3 and 6.4 for vented lead acid batteries.

Note 9: With accumulators in serial connection, apply a discharge current and after half time measure the voltage differential between two connection points.

a) The voltage differential shall be lower than 15mV for accumulators in the same row;

b) The voltage differential shall be lower than 50mV for adjacent accumulators between rows, on the same rack.

Note 10: Collect samples of metal parts and determine chemical analysis in compliance with design.

Note 11: Collect vessel, lid, separators, envelopes, side shims and safety filters samples, and identify their compositions in compliance with design.

Note 12: After carrying out lid and vessel residual stress measuring the result does not present microcracks and cracks.

Note 13: After applying pressure atmosphere, accumulators shall not leak electrolyte or gas at the pole-lid and lid-vessel junctions, as well as not have damage to their physical constitution.

Note 14: Tests to be carried out in one additional complete accumulator vessel, defined by PETROBRAS. Any non-conformity found the complete batch shall be considered as disapproved.

Note 15: Mass with tolerance of ± 4% for vented lead acid and according with manufacturer standards for other batteries type.

14 ANNEX I – ABBREVIATIONS AND ACRONYMS

ABNT	Associação Brasileira de Normalização Técnica
AH	Ampere-hour
ANSI	American National Standards Institute
DC	Direct Current
DIN	Deutsches Institute für Normung
EMC	Electromagnetic Compatibility
ET	Technical Specification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrotechnical and Electronic Engineers
LI	List
MCC	Motor Control Centre
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

RFI	Radio Frequency Interference
VRLA	Valve Regulated Lead Acid
VSD	Variable Speed Drive
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply