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SRGE	TITLE:		DESIGN, CONSTRUCTION AND ASSEMBLY OF FRP PIPING			INTERNAL
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FORM OWNED TO PETROBRAS N-0381 REV.L.

1 SCOPE

This technical specification sets the minimum requirements for design, assembly, commissioning and pre operation of fiber-reinforced plastics (FRP) piping systems on FPSO units.

2 REFERENCE AND ADDITIONAL DOCUMENTS

All equipment shall comply with the requirements of this technical specification and references stated below. All equipment parts and details not complying with any of these requirements shall be informed on a "Deviation List". Otherwise they will be considered as "Agreed", and so required.

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

2.1 CLASSIFICATION

SELLER/ MANUFACTURER shall perform the work in accordance with the requirements of Classification Society.


SELLER/ MANUFACTURER is responsible for submitting to the Classification Society all documentation in compliance with stated Rules.

2.2 REFERENCE DOCUMENTS

- ASME B31.3 - Process Piping.
- ASME B16.5 – Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
- ASME B16.47 - Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard
- ASME BPCV Section V – Nondestructive Examination
- ISO 14692 - Petroleum and Natural Gas Industries: Glass-Reinforced Plastics (FRP) Piping (parts 1 to 4).
- ASTM D 3567 – Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings.
- ASTM D 4024– Standard Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges;
- ASTM D 5421 – Standard Specification for Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges;
- ISO 9712– Non-destructive testing: Qualification and Certification of NDT Personnel;
- ISO 17024 – Conformity Assessment: General Requirements for Bodies Operating Certification of Persons.
- ASTM D 2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor;

2.3 GOVERNAMENTAL REGULATION

- NR 13 Caldeiras, Vasos de Pressão, Tubulações e Tanques Metálicos de Armazenamento (Boilers, Pressure Vessels, Piping and Metalic tanks)
- NR 26 Sinalização de Segurança (Safety Signaling)
- NR-37 Saúde e Segurança em Plataformas de Petróleo (Platforms Health and Safety)

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

2.4 DESIGN SPECIFICATIONS

DR-ENGP-I-1.15	COLOR CODING
I-ET-3010.00-1200-956-P4X-002	GENERAL PAINTING
I-ET-3010.00-1200-970-P4X-004	NON-DESTRUCTIVE TESTING REQUIREMENTS FOR METALLIC AND NON-METALLIC MATERIALS
I-ET-3010.00-1200-200-P4X-116	REQUIREMENTS FOR BOLTED JOINTS ASSEMBLY AND MANAGEMENT
I-ET-3010.00-1200-970-P4X-003	REQUIREMENTS FOR PERSONNEL QUALIFICATION AND CERTIFICATION

2.5 PROJECT SPECIFICATION

[PIPING SPECIFICATION FOR TOPSIDE]

[PIPING SPECIFICATION FOR HULL]

[METOCEAN DATA]

[MOTION ANALYSIS]

[REQUIREMENTS FOR PIPING STRESS AND DYNAMICS ANALISYS]

[MINIMUM REQUIREMENTS FOR PIPING MECHANICAL DESIGN AND LAYOUT]

[REQUIREMENTS FOR PIPING SUPPORT]

2.6 CONFLICTING REQUIREMENTS

2.6.1 In case of conflicting information between this Specification (ET) and other specific PETROBRAS' document (data sheet) the specific PETROBRAS' document shall prevail.

2.6.2 In all cases of conflict between this specification and applicable documents listed herein, the more stringent requirements shall prevail. In such cases, SELLER/ MANUFACTURER shall inform PETROBRAS of the conflict and seek clarification.

3 DEFINITIONS AND ABBREVIATIONS


3.1 DEFINITIONS

For the purposes of this specification, the terms and definitions given in ISO 14692-1 are applied. In addition, consider the following definitions:

SUPPLIER: manufacturer of FRP pipes and pipes accessories that, necessarily, shall be responsible for the construction, assembly and installation of piping system and responsible for flexibility analysis and supporting of piping systems.

3.2 ABBREVIATIONS

FRP - Fiber Reinforced Plastic
Tg – Glass transition temperature
RT – Radiographic testing

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UT – Ultrasonic testing
ITP- Inspection and test plan

4 PERSONNEL QUALIFICATION FOR CONSTRUCTION AND ASSEMBLY

4.1.1 Personnel qualification, following ISO 14692-4 shall be provided for pipe fitters/bonders/laminators, supervisors and inspectors.

4.1.2 The SELLER shall submit evidence of theoretical and practical training of pipe fitters/bonders/laminators previously the start of the project.

4.1.3 Training shall be provided by the pipe manufacturer and shall contain general aspects of composite pipes and specific aspects for SUPPLIER product (manufacturer, diameter and pressure class) and the types of joints to be used in the current project. The course shall consist of theoretical and practical part, meeting the minimum requirements of ISO 14692 - Part 4.

4.1.4 The basics topics of the course are:


- a) terminology, types of pipe, manufacture/fabrication, applications;
- b) material properties and engineering requirements;
- c) health, environment and safety;
- d) joining methods and procedures, including typical defects and failure modes;
- e) procedures for measuring electrical continuity;
- f) transport, handling and storage;
- g) installation;
- h) repairs;
- i) quality assurance and control, including methods of inspection;
- j) practical training in pipe joining (adhesive bonding, laminated, and flange connections). This activity may be conducted as part of the supplier-specific course, if appropriate.

4.1.5 All professionals shall be certified by independent certification bodies, national or international ones, according to ISO 14692.

4.1.6 Certification involves application of tests for pipe fitters/bonders/laminators, inspectors and supervisors after training by a third part (which may be the SUPPLIER) before beginning of installation.

4.1.7 There shall be a SUPPLIER Supervisor and a SELLER Inspector, who shall have 24 months proven experience in construction of FRP piping system and in the specific project unions / joints types. Besides SELLER inspector, at least one SUPPLIER Supervisor shall be present on site in FULL TIME.

4.1.8 Every SELLER team involved in the assembly and erection (installation) of the FRP piping system should consist of at least 60% of experienced staff in this type of material for oil and gas industry. Previous experience should consider the type of joint, pipe diameter, pressure class and manufacturer. (Ex: previous experience with bonded joints does not apply to laminated joints and vice-versa).

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5 HANDLING AND TRANSPORTATION

5.1.1 The **SELLER** shall submit, in conjunction with SUPPLIER, a procedure for shipping and handling of pipes and fittings for PETROBRAS's approval. The transport and handling of composite pipe items shall follow the guidelines of ISO 14692-4 and SUPPLIER specific requirements. The **SELLER** is responsible for the handling and transportation in accordance with approved procedure.

5.1.2 The handling shall be carried out carefully avoiding any impact. It is recommended that the pipe, fittings and pre-assembled sections be loaded and unloaded individually. Pipes and fittings shall be transported by suitable trucks and protected to prevent slip and abrasion between each other.

5.1.3 Factory spools shall be kept in original container transport, protecting pipe ends and joints, to final assembly in the field. Preassembled parts shall not be stacked or placed on surfaces that may cause harm (rocks, for example).

5.1.4 For load lifting it shall be used only proper synthetic fiber straps (eg, polyamide or polyester) or canvas. Chains, ropes, steel cables, clamps or any other material that may damage the FRP shall not be used.

5.1.5 Standard pipe lengths shall be raised up in two support points, ensuring the weight is well balanced. Attention shall be taken to ensure that polyamide or canvas lifting belts are always placed around the larger sections of pipe. If necessary, extension bar and additional lifting belts shall be used to prevent bending.

5.1.6 Lifting cranes are generally used for pipe loading and unloading. If a forklift is used, the forks should be covered with some kind of padding, such as rubber or plastic. Forks should never be put inside the pipe unless a special pipe handling tube is used which can be attached to the forklift.

6 DELIVERY INSPECTION

6.1.1 The SUPPLIER shall submit to PETROBRAS approval a delivery inspection procedure for pipes, fittings and all consumables to be used in the project as per ISO 14692-4.

6.1.2 The **SELLER** delivery inspection team shall have proper and documented qualification / training and be sized to meet the demand of expected materials delivery inspection.

6.1.3 Before unloading the pipes, fittings and consumables at site, the **SELLER INSPECTION** shall check all documentation and perform the visual inspection, according to ISO 14692-4. The state of preservation and storage of pipes, fittings and prefabricated spools during transport shall be checked regarding the protection of pipes and fittings edges, stacking, moorage, fixing and support of the materials on the transport vehicle.

6.1.4 The **SELLER** shall perform the delivery inspection (pipes, fittings and consumables) ensuring that they are in compliance with the applicable material requisition (RM), i.e. type, quantity, qualified pressure, nominal sizes, minimum thickness and specific contract requirements, etc. and considering the applicable technical specification (ET), material certificates, reports of manufacturing test.

6.1.5 The site facilities shall be appropriate and consider specific locations to segregated materials. Measuring instruments used for the material delivery inspections shall be verified and present calibration certificated within the period of validity.

6.1.6 The defect types, acceptance criteria and corrective actions, related to materials delivery inspection shall be in accordance with ISO 14692-4. In addition, imperfections such as kneading, warping, blistering, excessive peeling, pores and degradation spots are not accepted.

6.1.7 All materials used for construction of the piping system shall be properly identified and shall be from the same SUPPLIER or nominated and approved by the SUPPLIER.

6.1.8 All materials shall be re-inspected prior to spools fabrication and installation in order to find possible damages caused during the storage period.

6.1.9 Dimensional inspection of pipes and fittings shall be performed according standards defined at piping specification from manufacturer.

6.1.10 An electrical conductivity testing shall be performed according to ISO14692-2 at each lot of incoming material.

6.1.11 Total thickness measurement to verify the middle of pipe body shall be performed as well as at the pipes and fittings ends. The thickness measurement may be performed using by ultrasound, calibrated caliper or Pi tape.

7 STORAGE AND PRESERVATION

7.1.1 The SELLER is responsible for the storage and preservation and shall submit, in conjunction with the SUPPLIER, for PETROBRAS approval a storage and preservation procedure for pipes, fittings and consumables in accordance with Annex B of ISO 14692-4.

7.1.2 The storage facilities shall be in accordance with of ISO 14692-4 and SUPPLIER specific requirements. Facilities shall consider specific locations for segregated materials. Environmental conditions in the consumables storage room (resins, adhesives, catalysts, etc.) shall be controlled and monitored.

7.1.3 It shall be designated by the SELLER an inspection and preservation team with available and trained regarding FRP piping materials and consumables.

7.1.4 Storage shall use wooden sleepers or pallets, or other appropriate devices, in order not to damage the pipes or pipe coatings regarding to environmental degradation, kneading, warping, damage by impact, moisture, dust or chemical contamination.

7.1.5 The pipes and fittings cannot be arranged directly on the floor, rails or concrete floors.


7.1.6 Pipes, fittings, flanges and pre-assembled sections shall have end protections. If these components are stored in open area, the pipes shall be covered by canvas that promotes UV radiation protection.

7.1.7 Auxiliary materials such as resins, adhesives, paints, catalysts, chemicals in general, elastomeric sealing rings (O-rings), flange gaskets, fibrous reinforcements (mat, fabrics and roving) and lubricants shall be stored in accordance with manufacturer's recommendations in their original packaging whenever possible, protected from the sunlight, dust, humidity and heat.

8 DESIGN AND ASSEMBLY

8.1 GENERAL REQUIREMENTS

8.1.1 The SELLER shall ensure the correct application of materials, joints assembly, inspection and testing. The SUPPLIER shall provide tutoring of assemblers in all phases of construction and integrally supervise the work. The SELLER, under consulting and supervision of SUPPLIER, shall ensure proper implementation of installation, repair and field modifications procedures, subjecting such procedures and proposed changes to the approval of PETROBRAS. The SELLER shall submit all technical decisions during installation to the SUPPLIER and PETROBRAS.

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8.2 DESIGN

8.2.1 The services of fabrication, assembly, curing, cleaning, inspection, and testing of systems and components of FRP piping shall be executed according to procedures prepared in accordance with the standards considered in the Contract, Technical Specifications and in accordance with the requirements under applicable PETROBRAS Safety Standards. At least the project specifications listed at item 2.5 shall be considered.

8.2.2 SELLER shall submit for PETROBRAS approval an installation procedure in accordance with of ISO 14692-4.

8.2.3 The SUPPLIER shall present the calculus memory for the adhesive and laminated joints strength.

8.2.4 The local conditions for safety, organization and cleaning shall be at satisfactory levels and according the QHSE PETROBRAS policy. Team workers shall be wearing all personnel protection equipment necessary to perform the task safely.

8.2.5 For marine, industrial and process applications, the types of unions/joints are limited to: laminated joint ("butt-and-strap joint", "butt-and-wrap joint"), bonded/adhesived joints (spigot and bell) and flanged joint, depending on the application.

8.2.6 Flanges joints are mandatory between joints of different piping specs (i.e. metallic and FRP flanged joints).

8.2.7 Bonded/adhesived joints shall be spot (5%) inspected by radiography and/or ultrasonography. The inspected joints shall be those considered critical joints in flexibility and support analysis as well as surge analysis, when applicable.

8.2.8 The decision on the criticality of the joints (for application of NDT's - ultrasound and radiography) is responsibility of the SUPPLIER. The final project with identification of each critical joint shall be submitted for PETROBRAS approval. PETROBRAS reserves the right to define the critical joints, if necessary.

8.2.9 The flexibility of FRP pipping systems shall be performed in accordance with I-ET-REQUIREMENTS FOR PIPING STRESS AND DYNAMICS ANALISYS. The supports used shall be based on typical supports and ISO 14692.

8.2.10 The SELLER shall perform dimensional and flexibility analysis of the supports and pads. The flexibility analysis report shall be approved by the SUPPLIER.

8.2.11 The SELLER shall perform measures of alignment, spacing, verticality, leveling, inclination and curves angle of the various sections of pipe system. Design standards of the pipe system shall be respected, as well as standards for fabrication and properties of pipes and fittings.

8.3 SPOOLS FABRICATION AND ASSEMBLY

8.3.1 Professionals involved in pre-assembly shall be qualified and the SELLER's responsible for installation shall be involved in all stages of the work.

8.3.2 The criteria used for spooling shall consider as minimum: joints, fittings, dimensions, maximum weights and accessory position. It shall be minimized the use of connections and installation of fittings in field, prioritizing the assembly in the spools during fabrication or pipe-shop.

8.3.3 All materials transported from the storage area to the pipe shop shall go through inspection for integrity assessment.

8.3.4 The coupling devices for bonded/adhesived joints shall be described in the spool fabrication and installation procedures.

8.3.5 All joints (bonded or laminated) shall be fully supported, clamped, and braced to ensure that no movement occurs during the curing process.

8.3.6 The joining procedure shall be qualified by the SUPPLIER and approved by PETROBRAS. The same procedure shall be used for pipe joining in pipe shop and field, each step checked and inspected by the SELLER's INSPECTION, according to specific items for each type of joining, considering item 8.4.

8.3.7 Finished spools shall be inspected regarding dimensions, alignments between different components and applied material, meeting the specified tolerances. The inspection shall be performed by a qualified inspector.

8.3.8 The first prefabricated joint of each bonder shall be pressure tested according to item 9.3 prior to further bonding. If any joint fails, the next three joints shall be pressure tested. If another joint fails, the bonder must be re-qualified or relieved from further bonding duties. Testing shall be witnessed by PETROBRAS representative.

8.3.9 At least 10% of the prefabricated spools shall be pressure tested prior to the final installation at 1.5 of design pressure of the piping spec for a minimum period of one hour. In case of failure, re-testing shall be performed according to the requirement of ISO 14692-2.

8.3.10 The handling and movement of prefabricated components to its final installation site shall meet the specific procedure of the SUPPLIER in accordance with item 0 of this technical specification. All openings parts shall be protected or capped.

8.3.11 All flanges joints and bolted connections shall be assembled as per the requirements of I-ET-3010.00-1200-200-P4X-116 – REQUIREMENTS FOR BOLTED JOINTS ASSEMBLY AND MANAGEMENT and following SELLER's procedure, based on SUPPLIER's torque table for specific component.

8.3.12 Bolts, gaskets and lubricants to be used shall always be in accordance with the approved design and assembly procedure.

8.4 JOINTS REQUIREMENTS

8.4.1 Adhesive Bonded Joints

8.4.1.1 The assembly procedure shall contain a specific item for the execution of adhesive bonded joints. It shall be a qualified bonding procedure (Bonding Procedure Specification), in accordance with ISO 14692-4.

8.4.1.2 A mock up joint, representative of the scope of work, shall be adhesive bonded in accordance with the qualified procedure and fully tested before the beginning of the construction.

8.4.1.3 During the bonding process, the assembly inspector shall control and record at least the following items: fitters/bonders identification, material traceability (including adhesive), ambient conditions (e.g. relative humidity, temperature, direct incidence of sunlight), integrity of the ends of pipes, surface preparation. The recommendations of pipe manufacturer regarding bonding shall be observed.

8.4.1.4 Degree of cure of the bonded joint shall be checked after full cure according to ISO 14692-4. Visual inspection and nondestructive testing shall be performed after complete curing of the adhesive. The acceptance criteria for visual inspection shall be in accordance with ISO 14692-4.

8.4.2 Laminated Joints

8.4.2.1 The assembly procedure shall contain a specific item for the execution of laminated joints. It shall be a qualified procedure (Lamination Procedure Specification) in accordance with ISO 14692-4.

8.4.2.2 A mock up joint, representative of the scope of work, shall be laminated in accordance with the qualified procedure and fully tested before the beginning of the construction.

8.4.2.3 During the lamination process, the assembly inspector shall control and record at least the following items: fitters/bonders identification, material traceability, ambient conditions (e.g. relative humidity, temperature, direct incidence of sunlight), integrity of the ends of pipes, surface preparation. The recommendations of pipe manufacturer regarding bonding shall be observed.

8.4.2.4 The preparation and mixing of the resin and hardener shall be performed according to the manufacturer recommendations and procedure.

8.4.2.5 Laminated joint curing process shall be checked for the time of heat application, if applicable (blankets, furnaces, blowers, others), heating curve, gel time and cure time, even if the cure takes place at room temperature.

8.4.2.6 Degree of cure of the laminated joint shall be checked after full cure according to ISO 14692-4. Visual inspection and nondestructive tests shall be performed after complete curing of the resin. A visual inspection shall be carried out considering the acceptance criteria of ISO 14692-4.

8.4.3 Flanged Joints

8.4.3.1 The assembly procedure shall contain a specific item for the execution of flanged joints. It shall be a qualified procedure (Flanged Joint Procedure Specification) in accordance with ISO 14692-4 and pipe manufacturer's flange torque table.

8.4.3.2 For joints between FRP and other pipe spec or equipment, a composite flange shall be used. The gasket shall be according piping spec.

8.4.3.3 The SELLER's assembly procedure for flanged joints shall detail the maximum torque and sequencing of flange screws, in accordance with ISO 14692-4 and pipe manufacturer's flange torque table.

8.4.4 Repair Joints

8.4.4.1 The SELLER shall issue a repair procedure indicating the method to be used for each type of defect. The repair shall follow ISO 14692-4. The repair method employed shall fully restore the specified properties of the pipe, evaluated through hydrostatic testing and visual inspection.


8.4.4.2 No repairs shall be performed on the inner surface of the pipe or fittings. In this case, replacement of the pipe or component shall be performed.

9 NON-DESTRUCTIVE TESTS (NDT) AND HYDROSTATIC TEST

9.1 GENERAL REQUIREMENTS

9.1.1 The SELLER shall execute the following tests for FRP piping systems: visual inspection, dimensional inspection, barcol hardness, electric conductivity, radiographic and/or ultrasonic test, hydrostatic test and leak test. The procedures shall observe the requirements of I-ET-3010.00-1200-970-P4X-004 NON-DESTRUCTIVE TESTING REQUIREMENTS FOR METALLIC AND NON-METALLIC MATERIALS.

9.1.2 All joints assembled in field, factory or "pipe-shop" shall be identified and recorded in the log book, with the minimum relevant information according to ISO 14692-4. It shall be registered and identified in the joint if it is considered critical or not and if it was inspected by radiography and/or ultrasound.

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9.1.3 All joints between pipes, fittings and flanges, whether performed in the factory, "pipe-shop" or field, shall be inspected by a certified or qualified assembly inspector, in accordance with item 4 of this Technical Specification.

9.1.4 Any NDT, including visual inspection, Barcol hardness, ultrasound, radiography, and others shall be performed prior to performing hydrostatic testing. The visual inspection shall be carried out in the joints, compulsorily, before, during and after sealing and hydrostatic tests.

9.1.5 In case of base material defect identified, the repair is only accepted under previous SUPPLIER evaluation and approval of repair procedure.

9.2 SAMPLING

9.2.1 When sampling test is indicated (random examination), a percentage of the number of joints within the specified lot shall be selected, and the whole bonded / laminated length of the selected joint shall be inspected.

9.2.2 A LOT is defined as the total number of joints bonded / laminated during a period (not greater than three months), grouped by material specification (trademark), and by fitters/bonders and process (type of joint). Therefore a LOT may only contain:

- Joint from the same material;
- Joints with similar process;

9.2.3 Pipe shop joints(for the fabrication of spools) and on-site joints (for the field assembly of piping) shall be grouped in separated lots.

9.3 CRITICAL JOINTS

9.3.1 Spot NDT inspection shall be performed in the critical joints. The decision on the criticality of the joints is responsibility of the SUPPLIER, but is recommended to observe the following criteria in precedence order:


- a) Adhesive-bonded or laminated joints in lines with high axial stress (subjected to fatigue), detected during flexibility analysis.
- b) Field joints.
- c) "T" type fittings
- d) Adhesive-bonded or laminated joints close to valves
- e) Adhesive-bonded or laminated joints close to pumps
- f) Adhesive-bonded or laminated joints close to equipments
- g) Weld neck flange joints for B23H pipe spec

Note: a) and b) has same precedence in order to define critical joints.

9.3.2 The scope for selection of critical joins is those above 3" for all FRP specs and above 12" for B22 pipe spec.

9.4 NON-DESTRUCTIVE TESTS (NDT)

9.4.1 The SELLER, shall prepare and submit for approval of PETROBRAS a procedure for pressure testing and for performing nondestructive testing (NDT). These procedures shall be in accordance with ISO 14692- part 4 and ASME BPVC Section V article 1 and 14 (level B – intermediate rigor).

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9.4.2 The requested NDT for the joints shall consider the Annex E of ISO 14692-4. Inspection procedures shall be developed by Level 3 Certificated professionals and submitted for review of PETROBRAS.

9.4.3 Before any nondestructive testing, all joints (100%) shall be visually inspected (VT) to assure that the joint is free from defects. Visual testing of joints shall include a dimensional check of the joint and piping assembly tolerance according to ISO 14692-4.

9.4.4 X- Ray Radiographic (RT) and/or ultrasonic (UT) inspection shall be in accordance with item 8.2.

9.4.5 NDT (RT or UT) of joints in FRP piping shall be 5% of the total number of joints made by the same joining method. The **SELLER** shall follow the acceptance criteria per ISO 14692.

9.4.6 The results of visual inspection tests, Barcol hardness, leak test, hydrostatic test, radiography and ultrasound shall be recorded in a specific form. All tests shall be performed after complete curing of the resin or adhesive, or termination of a flanged joint.

9.4.7 Barcol hardness test shall be performed according to ASTM D 2583 with at least 4 measurements at each joint and at 10% of joints.

9.4.8 Electrical conductivity testing shall be performed per lot of joint according to ISO 14692-4

9.4.9 Penalties (Progressive Sampling for Examination) shall be applied to the welder/weld operator responsible for the defective weld as stated in ASME B31.3. The lot approval, replacement, repair and reexamination shall be as stated in ASME B31.3.

9.5 PRESSURES TESTING

9.5.1 All supports, guides, and anchors shall be installed prior to pressure testing. All adhesive or laminated joints shall be fully cured prior to pressure testing. Bolts of flanged joints shall be made up to correct torque prior to pressure testing.

9.5.2 The **SELLER** shall submit a hydrostatic and leak tests procedures for approval by PETROBRAS.

9.5.3 The test pressure shall be done at 1.5 times P_{des} . (where P_{des} is the specified spec design pressure).


9.5.4 The test pressure shall be gradually raised over a period of 30 min or longer up the required test pressure is achieved. The test shall be conducted for a minimum hold period of 2 hours during which time the test pressure shall be maintained with $\pm 2.5\%$ of the required test pressure with no test fluid being added or removed during the hold period of the test. The test hold period begin once stable conditions have been achieved.

9.5.5 The leak test pressure shall be 1.1 times P_{des} . For systems with elevation variations, the required pressure shall be achieved at the system lower point, in the system higher point the test pressure shall not be more than 1.0 time P_{des} . For large elevation variations, the system lower point test pressure may be increased above the required test pressure, however this shall not exceed 1.25 times P_{des} .

9.5.6 The leak test minimum hold period shall be sufficient time to inspect all joints and potential leak sources (for piping systems with the joints and other potential leak sources exposed for inspection). It considers a minimum duration of 2 hours.

9.5.7 Hydrostatic and leak tests can be done with fresh or salt water.

9.5.8 All lines that require a pressure test shall be washed before testing. Atmosphere opened systems and those not requiring pressure test shall be washed to ensure that the lines are not obstructed. The cleaning shall be performed according to ISO 14692.

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	TITLE: DESIGN, CONSTRUCTION AND ASSEMBLY OF FRP PIPING	INTERNAL	
		ESUP	

10 PAINTING

10.1 The pipes and fittings shall receive, during their manufacture, direct pigmentation in the resin or an external resin liner with anti-UV additive and pigment, with color in accordance with DR-ENGP I-1.15.

10.2 In case of requirement of painting the I-ET-3010.00-1200-956-P4X-002 shall be complied.

11 INSPECTION AND TEST PLAN AND REPORTS

11.1 The **SELLER** shall provide a ITP which includes inspection, fabrication and assembly, and during different steps.

- a) Raw material control;
- b) Fabrication parameters;
- c) Pre-fabrication on site/ on FPSO;
- d) Assembly;
- e) Tests.

11.2 Final reports shall be established following the size of the whole project or individual assemblies. Final reports shall include:

- a) Quality Plan;
- b) Assemblies identified on isometrics - bonding or laminations with identification of the fitter who has performed them;
- c) Control of joints.
- d) Hydrostatic test reports.
- e) NDT reports.