PETROBRAS	**TECHNICAL SPECIFICATION**	**Nº:** I-ET-3000.00-1500-823-PEK-001	
	CLIENT: E&P		SHEET 1 OF 21
	PROGRAM: SUBSEA PRODUCTION SYSTEMS		
	AREA: SUBSEA CONTROL AND MONITORING SYSTEMS		
SUB/ES/ EECE/ECE	**TITLE:** **QUALIFICATION OF WET-MATE ELECTRICAL CONNECTORS AND ACCESSORIES**		PÚBLICA

LIST OF REVISION

REV.	DESCRIPTION OR PAGES MODIFIED
0	Original
A	Modification of title. Previous version: “Qualification Tests for Subsea Electrical Control and Monitoring Systems”. Revision based on DIP SUB/ES/DCT/CDRT 4/2018.
B	Revision in Well Completion Fluids Test of qualification and Documentation.
C	New revision in Well completion Fluids Test

UR6A Assinado de forma digital por UR6A Dados: 2020.06.16 09:43:29 -03'00'

CTMK Assinado de forma digital por CTMK Dados: 2020.04.10 18:25:08 -03'00'

Carlos Antonio Pereira Viana Assinado de forma digital por Carlos Antonio Pereira Viana DN: c=BR, o=ICP-Brasil, ou=Autenticado por AR Certifique Online, ou=Assinatura Tipo A3, cn=Carlos Antonio Pereira Viana Dados: 2020.04.07 14:49:01 -03'00'

	REV. 0	REV. A	REV.B	REV.C						
DATE	01/23/2013	12/21/2018	30/08/2019	07/04/2020						
PROJECT										
EXECUTED BY	ES34	CLW4 / ES34	CLW4 / ES34	CLW4						
VERIFIED BY	CTMK, CQP1	CTMK	CTMK / U5E5	CTMK						
APPROVED BY	HM80	UR6A	UR6A	UR6A						

SUMMARY

1 GENERAL

1.1 Purpose

1.1.1 This document describes the minimum routine of tests for the qualification of subsea wet-mate electrical connectors and their accessories, for application in subsea control and monitoring systems (SC&MSs). Examples of connector accessories comprised by this document are jumpers, junction boxes, and penetrators. SC&MSs are part of subsea production systems in petroleum industry and are defined as per standards API 17F and ISO 13628-6.

1.1.2 The sufficiency of this technical specification depends on the particularities of each connector or accessory and can be modified with complementary requirements by PETROBRAS for the effective implementation of any particular qualification process.

1.2 List of acronyms

Acronym	Description
ac	alternating current
SC&MS	subsea control & monitoring system
dc	direct current
MTTF	mean time to failure
ppm	part/parts per million
rms	root mean square
SWT	sea water tank
TS	technical specification

1.3 Background

1.3.1 For easiness of notation, a subsea wet-mate electrical connector for control and monitoring systems will be shortly called as CONNECTOR throughout this document.

1.3.2 Any CONNECTOR or CONNECTOR accessory intended to be qualified is also referred to as DEVICE throughout this document.

1.3.3 The supplier that will to qualify a given DEVICE is referred to as SUPPLIER in this document.

1.3.3.1 The SUPPLIER can propose, for PETROBRAS approval, the minimum sufficient adaptations on this TS qualification routine to apply it to the correspondent DEVICE.

1.3.4 The tests of this TS qualification routine are mandatory for any new DEVICE intended to be supplied to PETROBRAS. The SUPPLIER whose DEVICE has eventually been upgraded after original qualification approval shall present a report arguing whether a new qualification process is necessary or not.

1.3.5 Any adaptation on this TS qualification routine shall be agreed between SUPPLIER and PETROBRAS.

1.3.5.1 To qualify the DEVICE, the SUPPLIER shall ensure, by means of additional tests, that any DEVICE accessory is in conformity with this TS.

1.3.5.2 Complementary documentation regarding DEVICE technical specifications can be requested by PETROBRAS as part of the qualification process.

1.3.5.3 PETROBRAS can require additional tests depending on the existence of novel technologies that are released in the DEVICE.

1.4 References

1.4.1 The following standards, bibliography, and PETROBRAS documents (latest editions) are applicable for qualification of CONNECTORS and their accessories:

1.4.1.1 IEC 60502-2: Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1.2 kV) up to 30 kV (Um = 36 kV) – Part 1: Cables for rated voltages of 1 kV (Um = 1.2 kV) and 3 kV (Um = 3.6 kV);

1.4.1.2 IEC 60212: Standard conditions for use prior to and during the testing of solid electrical insulating materials;

1.4.1.3 IEC 60270: High-voltage test techniques – Partial discharge measurements;

1.4.1.4 IEC 60885-2: Electrical test methods for electric cables Part 2: Partial discharge tests;

1.4.1.5 API 17F: Standard for Subsea Production and Control Systems;

1.4.1.6 ISO 13628-6: Petroleum and natural gas industries – Design and operation of subsea production systems – Part 6: Subsea production control systems;

1.4.1.7 Lafferty, J.M., “Foundations of Vacuum Science and Technology,” John Wiley & Sons, New York, USA, 1998;

1.4.1.8 Kececioglu, D., “Reliability and life testing handbook,” v. 1 and 2, PTR Prentice-Hall, Englewood Cliffs, USA, 1993;

1.4.1.9 BSI BS 5691-1: Guide for the determination of thermal endurance properties of electrical insulating materials – Part 1: General guidelines for ageing procedures and evaluation of test results;

1.4.1.10 PETROBRAS ET-3000.00-1521-610-PAZ-001: Veículos de operação remota de intervenção;

1.4.1.11 PETROBRAS I-ET-3000.00-1516-823-PEK-003: Wet electrical connector for PDG;

1.4.1.12 PETROBRAS PE-2POC-00407: Composição e preparo de fluidos de completação salinos.

2 TECHNICAL DEFINITIONS

2.1 Rated voltages and currents

The following definitions are adopted throughout this TS:

2.1.1 V_{R0}: rated rms ac voltage between each DEVICE electrical path and earth.

2.1.2 V_R: rated rms ac voltage between each pair of electrical paths of a same DEVICE.

2.1.3 I_R: rated rms ac electrical current through each DEVICE electrical path.

2.2 Electrical resistances

The following definitions are adopted throughout this document:

2.2.1 *Contact resistance* (R_C): resistance offered to an electrical current during its passage through a given DEVICE electrical path.

2.2.2 *Conductor-housing insulation resistance* (R_{I0}): resistance offered by the insulation materials to produce a current leakage while a voltage is applied between the DEVICE housing and a given DEVICE electrical path.

2.2.3 *Conductor-conductor insulation resistance* (R_I): resistance offered by the insulation materials to produce a current leakage while a voltage is applied between two given electrical paths of a DEVICE.

2.3 Maximum misalignment (M_{max}) at matting

2.3.1 CONNECTORS shall tolerate a maximum radial misalignment (M_{max}) during mating, as well as maintain their electrical characteristics. The radial direction is perpendicular to the axial direction of matting.

2.4 Sea water temperature (T_{sw})

2.4.1 For the purpose of these qualification tests, define the sea water temperature $0° \leq T_{sw} \leq 4.5°$ C.

2.5 Ambient temperature (T_{amb}) and humidity (H_{amb})

2.5.1 Unless otherwise specified, magnitude of T_{amb} during tests shall be in accordance with standard IEC 60502-2 Item 15.1, namely $5º \leq T_{amb} \leq 35º$ C.

2.5.2 Unless otherwise specified, magnitude of H_{amb} during tests shall be in accordance with standard IEC 60212 Table 2 “standard ambient” condition, namely $45\% \leq H_{amb} \leq 75\%$.

2.6 Maximum pressure at environment of operation (P_{env})

2.6.1 The DEVICE shall operate when subjected to levels of pressure up to P_{env}.

2.7 SWT settings

2.7.1 To simulate conditions of environments where the DEVICE is designed to operate, specific tests shall be performed in an SWT. Unless otherwise stated, a 35,000 ppm NaCl solution plus both river silt and sand (respectively 1.0% and 0.5% by weight) fills the SWT and is agitated during all the experiment.

2.7.2 Granulometry shall be addressed as follows: *river silt* particles are uniformly distributed between 2 and 50 μm; and *sand* grains are uniformly distributed between 50 and 500 μm.

2.8 Life time (τ_L)

The life time τ_L is defined as the DEVICE MTTF. The MTTF definition is in accordance with Item 1.4.1.8.

2.9 Jumper techniques

This TS distinguishes jumpers implemented with pressure compensation, herein referred to as *hoses*, from those ones implemented with no pressure compensation, herein referred to as *cables*.

3 TECHNICAL SPECIFICATIONS

3.1 Required characteristics of DEVICES

The following DEVICE characteristics are mandatory:

3.1.1 Rated voltages $V_{R0} \geq 1000$ V and $V_R \geq 1732$ V

3.1.2 I_R requirements:

3.1.2.1 DEVICES except CONNECTORS: $I_R \geq 30$ A.

3.1.2.2 CONNECTORS with 6 or less electrical paths per device: $I_R \geq 20$ A.

3.1.2.3 CONNECTORS with 7 up to 11 electrical paths per device: $I_R \geq 20$ A.

3.1.2.4 CONNECTORS with 12 or more electrical paths per device: $I_R \geq 20$ A.

3.1.3 $R_C \leq 10$ mΩ.

3.1.4 $R_{I0} \geq 10$ GΩ.

3.1.5 $R_I \geq 10$ GΩ.

3.1.6 $M_{max} \geq 20$ mm.

3.1.7 $P_{env} \geq 30$ MPa.

3.1.8 $T_L \geq 25$ years.

3.2 Mandatory electrical measurements during qualification tests

3.2.1 Measurement of resistances R_C, R_{I0}, and R_I shall be performed over the specimens at least before and after all the qualification tests.

3.2.2 Contact resistance R_C shall be indirectly obtained by measuring the voltage between – as near as possible – the extremes of each DEVICE electrical path while a current, namely I_R, is being passed through. The measurement shall be carried out using the four-wire technique. Specifically for CONNECTORS, R_C shall be evaluated on a pair of mated CONNECTORS, between the extremes of each electrical path.

3.2.3 Insulation resistance R_{I0} shall be recorded at least at voltage 500 V (dc) in snapshots at the 1, 5, and 10 min moments. All the combinations of electrical path pairs shall have their respective resistances recorded. Both T_{amb} and H_{amb} during measurements shall be recorded as well.

3.2.4 Insulation resistance R_I shall be recorded at least at voltage 500 V (dc) in snapshots at the 1, 5, and 10 min moments. All the combinations of electrical path pairs shall have their respective resistances recorded. Both T_{amb} and H_{amb} during measurements shall be recorded as well.

4 QUALIFICATION ROUTINE

Qualification routines shall be composed at least by all tests presented in this section. Order of test execution, as well as number of specimens for tests, is arbitrary, unless otherwise stated in this TS. The electrical measurements described in Section 3.2 shall be performed at least before and after all the qualification tests.

4.1 Voltage withstanding test

4.1.1 DEVICES shall withstand a voltage of 3 V_{R0} for a period of 4 h. The assembly voltage source shall be implemented by a “hipot” tester (megohmmeters are not allowed).

4.1.2 A pair of mated CONNECTORS shall withstand a voltage of 3 V_{R0} for a period of 4 h. The assembly voltage source shall be implemented by a “hipot” tester (megohmmeters are not allowed).

4.1.3 No breakdown shall be observed while voltage is applied.

4.2 Partial discharge test

4.2.1 The SUPPLIER shall propose, for PETROBRAS approval, a partial discharge test according to IEC 60270 and IEC 60885-2 standards, to address the long-term quality of the DEVICE electrical insulation material.

4.3 Thermal cycles in pressure test

4.3.1 During this test, a specimen is composed by a pair of CONNECTORS (plug plus receptacle).

4.3.2 In the scope of Item (4.3), define *cycle* as the following serial events:

4.3.2.1 Passing of current I_R through all electrical paths of the specimen during 5 h (connectors are mated);

4.3.2.2 No intervention on arrangement during 3 h (connectors remain mated);

4.3.2.3 Measurement of R_C, R_{I0} and R_I; meanwhile, checking of breakdown;

4.3.2.4 De-mating and mating of connectors;

4.3.2.5 Measurement of R_C, R_{I0}, and R_I; meanwhile, checking of breakdown.

4.3.3 The test consists on performing 3 events of de-mating and mating in 0.1 P_{env}, followed by performance of 30 cycles in P_{env}.

4.3.4 The pressure transition during test, from 0.1 P_{env} to P_{env}, can be performed by a 5 min step with an arbitrary intermediate pressure level.

4.3.5 During the test, no breakdown shall be observed in any cycle while Items (4.3.2.3) and (4.3.2.5) are performed.

4.4 Temperature raise test

4.4.1 A pair of mated CONNECTORS shall be subject to electrical current, namely I_R. When thermal equilibrium is reached, temperature on – as close as possible – hottest points of the specimens shall be acquired and shall be no higher than T_{amb} + 30° C.

4.4.2 After current is vanished, the connectors shall be disassembled to inspection. No deterioration shall be observed.

4.4.3 Connector ACCESSORIES shall be submitted to this test as well.

4.5 Short-circuit test

4.5.1 A pair of mated CONNECTORS shall be subjected to a current at least equals to 5 I_R, applied for at least 5 s.

4.5.2 No deterioration shall be observed on CONNECTORS after test is finished.

4.5.3 Connector ACCESSORIES shall be submitted to this test as well.

4.6 High-voltage breakdown test

4.6.1 A specimen composed by the DEVICE with all its first pressure barriers removed – diaphragms, seals, etc. – shall be pressurized in P_{env} and submitted to a 5 V_{R0} voltage during at least 5 min. No breakdown shall be observed. The assembly voltage source shall be implemented by a “hipot” tester (megohmmeters are not allowed).

4.6.2 After execution of Item (4.6.1), the specimen shall be submitted to pressure 1.5 P_{env} (no voltage is applied), then removed from the pressure vessel to be submitted to voltage levels in increasing steps, until breakdown occurrence or reaching to the 10 V_{R0} level. Breakdown is allowed to occur at voltage levels higher than 5 V_{R0}. The assembly voltage source shall be implemented by a “hipot” tester (megohmmeters are not allowed).

4.7 Helium leak test

4.7.1 DEVICES with sealing mechanisms shall be submitted to test of leak detection in temperature T_{amb}. The leak detection shall be based on the tracer gas method, and the test assembly shall be set in accordance with the counter flow method. The mean leakage rate, at stationary regime, shall be lower than 10^{-7} Pa·m^3/s (standard helium-4 leak rate assuming 10^5 Pa of pressure difference between air and vacuum).

4.7.2 To qualify CONNECTORS, both plug and receptacle specimens shall be submitted to this test.

4.7.3 For sake of reference in leak detection, see Item (1.4.1.7).

4.8 Test of maximum misalignment and integrity of locking device

4.8.1 For a specimen composed by a pair of plug and receptacle, the following misalignment settings shall be tested by application of 2 (serial) cycles of mating and de-mating:

4.8.1.1 Connectors misaligned in x axis by $+M_{max}$;

4.8.1.2 Connectors misaligned in x axis by $-M_{max}$;

4.8.1.3 Connectors misaligned in y axis by $+M_{max}$;

4.8.1.4 Connectors misaligned in y axis by $-M_{max}$;

4.8.2 For sake of orientation in tests of Item (4.8.1), the plane formed by the x-y axes shall be perpendicular to the axial direction of connection.

4.8.3 The x axis shall be carefully chosen to simulate the most stringent misalignment condition.

4.8.4 Once the x axis is defined, the y axis is given as the perpendicular axis in relation to the x one.

4.8.5 Accomplishment of both mechanical and electrical mating is mandatory during any attempt of connection during the test. Mechanical damage shall be not observed on the locking mechanism (if this mechanism does exist) after essays of Item (4.8.1) are performed.

4.9 Test of mating and de-mating forces

4.9.1 One pair of CONNECTORS shall be carried out by 100 cycles of mating and de-mating. At each cycle, the mating and de-mating forces shall be recorded and respectively compared to limiting performances above:

4.9.1.1 The mating forces shall be smaller than 250 N.

4.9.1.2 The de-mating forces shall be bigger than 200 N and smaller than 500

4.10 Pull test

4.10.1 This test is applicable to CONNECTORS with embedded locking mechanisms only.

4.10.2 An assembly composed by a pair of locked mated CONNECTORS shall be subjected to a 10 mm/min pulling, at axial direction of connection. The pulling shall be applied until damage happens or a 30 kN tensometer load is reached.

4.10.3 The CONNECTOR assembly shall present plastic deformation with a load no smaller than 10 kN. The CONNECTOR axial displacement shall not damage the sealing integrity.

4.11 Bending Test

4.11.1 A pair of mated CONNECTORS shall be subject to bending momenta from 170 to 680 N·m, at increasing steps of 14 N·m. Measurement of R_C, R_{I0}, and R_I shall be accomplished every step. Each momentum level shall be applied twice.

4.11.2 All bending moment shall be coincident, perpendicular to the axial direction of connection, and carefully chosen as the most stringent one.

4.11.3 After test, the CONNECTORS shall be disassembled and inspected. No damage shall be observed.

4.12 Twisting test

4.12.1 A pair of mated CONNECTORS shall be subject to twisting momenta from 170 to 680 N·m, at increasing steps of 14 N·m. Each momentum level shall be applied twice. Measurement of R_C, R_{I0}, and R_I shall be accomplished every step.

4.12.2 All twisting moment shall be coincident with the axial direction of connection.

4.12.3 After test, connectors shall be disassembled and inspected. No damage shall be observed.

4.13 Jumper pull test

4.13.1 For DEVICES that interface with hoses, the SUPPLIER shall propose a test to verify that the DEVICE is robust on hose pull forces up to the SUPPLIER rated maximum pulling, for Petrobras approval.

4.13.2 For DEVICES that interface with cables, the following test shall be implemented:

4.13.2.1 A specimen composed by a DEVICE linked with a cable length shall be subjected to pulling at rate of 10 mm/min until failure occurs with the collet cable grip.

4.13.2.2 Failure is allowed to be only: a 2 mm slip of cable by the collet at load bigger than 1 kN; or on the cable sheath.

4.14 Oscillating jumper test

4.14.1 A specimen composed by a CONNECTOR linked with a jumper length shall be mounted in a setting to simulate both sea currents and tidal effects on the CONNECTOR-jumper link. The simulation shall be composed by 250,000 cycles at rate of 4.5 cycles per minute.

4.14.2 After simulation, the specimen shall be disassembled and inspected. No damage shall be observed.

4.14.3 For CONNECTORS linked to cables, complementary visual inspection shall reveal that the clamping mechanism is operational; that no displacement between cable and gland happened; and that the cable did not suffer twisting.

4.14.4 DEVICES others than CONNECTORS shall be submitted to this test as well.

4.15 Seal extrusion of cable gland test

4.15.1 This test is applicable to DEVICES that interface with cables only.

4.15.2 The SUPPLIER shall propose a qualification test to prove that sealing of DEVICE-cable link is robust on unacceptable seal extrusion. The SUPPLIER shall adopt the most stringent scenario that an electrical cable of smallest admitted diameter is used.

4.16 Mating and de-mating test at SWT

4.16.1 A specimen composed by a pair of mated CONNECTORS shall be subjected to 100 cycles of mating and de-mating in an SWT, pressure 1.15 P_{env} and temperature T_{amb}. After each cycle, measurement of R_C, R_{I0}, and R_I shall be accomplished. Then the specimen shall be subjected to phase-earth dc voltage with magnitude 3.5 V_{R0}. Neither breakdown nor flash shall be observed while such voltage level is applied.

4.17 Pressure bursts test at SWT

4.17.1 The specimen shall be composed by a pair of mated CONNECTORS.

4.17.2 In the scope of Item (4.17), define *cycle* as the pressurization of the assembly from ambient pressure to P_{env}, followed by depressurization from P_{env} to ambient ressure. Both pressurization and depressurization rates shall be at least 6.9 MPa/s.

4.17.3 The test consists on performing the following serial events: 25 cycles; then pressurization of assembly in P_{env} during 24 h, followed by depressurization to ambient pressure.

4.17.4 After both the last cycle and the 24 h period, the specimen shall be subjected to phase-earth dc voltage with magnitude 3.5 V_{R0}. Neither breakdown nor flash shall be observed.

4.17.5 DEVICES others than CONNECTORS shall be submitted to this test as well.

4.18 Endurance Test

4.18.1 Every DEVICE insulation material shall be independently qualified by thermal endurance tests according to standard BSI BS 5691-1.

4.18.2 DEVICES shall be submitted to the experiments from item (4.18.4) to Item (4.18.6). Each experiment can be performed with independent specimens. Assembly

voltage sources shall be implemented by a “hipot” tester (megohmmeters are not allowed).

4.18.3 For CONNECTORS, each specimen shall be composed by a pair of mated connectors.

4.18.4 A specimen shall be set in an SWT (neither river silt plus sand nor agitation are required), at pressure 30 MPa, temperature T_{amb}, conductor-earth rms ac voltage 2500 V, and during a period of 24 h. No breakdown shall occur and sealing mechanisms shall maintain their operational properties.

4.18.5 A specimen shall be set in an SWT (neither river silt plus sand nor agitation are required), at pressure 45 MPa, temperature T_{amb}, conductor-earth rms ac voltage 1000 V, and during a period of 12 h. No breakdown shall occur and sealing mechanisms shall maintain their operational properties.

4.18.6 A specimen shall be set in an SWT (neither river silt plus sand nor agitation are required), at pressure 30 MPa, temperature T_{amb}, conductor current 2.8 I_R, and during a period of 12 h. No breakdown shall occur and sealing mechanisms shall maintain their operational properties.

4.19 Flooded devices test

4.19.1 The assembly shall be composed by a pair of mated CONNECTORS. Both plug and receptacle shall have the primary pressure barriers – diaphragms, seals, etc. – removed, keeping intact second barriers.

4.19.2 In the scope of item (4.19), define *cycle* as the following serial events:

4.19.2.1 Pressurization of assembly in $1.15P_{env}$ during a given period of time;

4.19.2.2 Depressurization of assembly.

4.19.3 The test consists on performing the following serial events: immersion of assembly in water for a period of 40 h; 2 cycles of 15 min; 1 cycle of 60 min; 1 cycle of 24 h; 5 cycles of 5 min.

4.19.4 Before and after each performed cycle, the assembly shall be subjected to measurement of R_C, R_{I0}, and R_I.

4.19.5 After test is finished, the assembly shall be inspected and no evidence of water ingress on secondary cameras of assembly shall be verified.

4.19.6 DEVICES others than CONNECTORS shall be submitted to this test as well.

4.20 Thermal shock test

4.20.1 The assembly shall be composed by a pair of mated CONNECTORS.

4.20.2 In the scope of Item (4.20), define *cycle* as the following serial events:

4.20.2.1 Heating of assembly until thermal equilibrium is reached in 70° C;

4.20.2.2 Plunging of assembly in water at T_{sw};

4.20.2.3 Cooling of assembly until thermal equilibrium is reached in –40° C;

4.20.2.4 Complementary plunging of assembly in water at T_{sw}.

4.20.3 The test consists on performing 3 cycles.

4.20.4 After test is finished, the assembly shall be inspected and its integrity shall be verified.

4.20.5 DEVICES others than CONNECTORS shall be submitted to this test as well.

4.21 Mechanical shock test

4.21.1 A pair of mated CONNECTORS shall be subjected to mechanical shock test according to ISO 13628-6 Item 11.2.5.2.1.

4.21.2 DEVICES others than CONNECTORS shall be submitted to this test as well.

4.22 Vibration test

4.22.1 A pair of mated CONNECTORS shall be subjected to vibration test according to ISO 13628-6 Item 11.2.5.2.2, using Q1 level settings.

4.22.2 DEVICES others than CONNECTORS shall be submitted to this test as well.

4.23 Drop test

4.23.1 Two DEVICE specimens shall be subjected to dropping: plug linked with a length of jumper, and receptacle linked with a length of jumper. CONNECTORS in both specimens can not be dropped with protection caps. The floor surface shall be concrete; a 5-mm mat can be placed over the floor. Dropping shall be performed from a height of 2 m, in air.

4.23.2 No damage is admitted on assemblies after test. Mating mechanism shall remain operational.

4.24 Pressure to destruction test

4.24.1 Two specimens shall be subjected to test: electrical insert mechanism of CONNECTOR (plug) and electrical insert mechanism of CONNECTOR (receptacle).

4.24.2 In the scope of item (4.24), define *differential pressure* Δp as the difference of pressure between the front and rear sides of an electrical insert mechanism.

4.24.3 Both specimens shall withstand at least $1.15P_{env}$ of Δp, without damage.

4.25 CONNECTOR handle test

4.25.1 The CONNECTOR handle shall conform to the Remotely Operated Vehicle (ROV) requirements of PETROBRAS, according to Item (1.4.1.10).

4.25.2 The specimen shall be composed by a CONNECTOR embedded with its handle device.

4.25.3 In the scope of Item (4.25), the plane formed by the horizontal and vertical axes shall be perpendicular to the axial direction of connection.

4.25.4 The test consists on performing the following serial events over the specimen:

4.25.4.1 Application of a 680 N·m momentum over the handle up to a 30° displacement on horizontal axis;

4.25.4.2 Application of a 680 N·m momentum over the handle up to a 30° displacement on vertical axis;

4.25.4.3 Application of a 680 N·m momentum over the handle to twist it in +5° and then in –5° (direction of momentum shall be the axial direction of connection);

4.25.4.4 Revolution of handle through a 30° cone for 10 times (the cone is concentric with the axial direction of connection).

4.25.5 The placements of all forces on the handle shall be carefully chosen as the most stringent ones.

4.25.6 No damage is admitted on the specimen after this test.

4.26 Compliant flange test

4.26.1 The assembly shall be composed by a CONNECTOR (plug) embedded into a compliant flange and a mated receptacle.

4.26.2 In the scope of item (4.26), the plane formed by the horizontal and vertical axes shall be perpendicular to the axial direction of connection.

4.26.3 The test consists on performing the following serial events over the assembly:

4.26.3.1 Application of a 680 N·m momentum over the receptacle to at least a 10° displacement on horizontal axis;

4.26.3.2 Application of a 680 N·m momentum over the receptacle to at least a 10° displacement on vertical axis;

4.26.3.3 Application of a 680 N·m momentum over the receptacle to twist it in +2° and then in –2° (direction of momentum shall be the axial direction of connection).

4.26.4 The specimen shall be complacent to the movements of Item (4.26.3), as well as the plug shall maintain captive to the flange.

4.27 Bulkhead flange test

4.27.1 The assembly shall be composed by a bulkhead flange embedded into a CONNECTOR (plug).

4.27.2 In the scope of Item (4.27), define the differential pressure Δp as the difference of pressure between the rear side and the plug side of the bulkhead flange.

4.27.3 The assembly shall be subjected to an increasing Δp, from zero to $1.15P_{env}$, at rate of $0.02\ P_{env}$/min. Then, the assembly shall be subjected to a decreasing Δp, from zero to $–0.35\ P_{env}$, at rate of $–0.02\ P_{env}$ /min.

4.27.4 The assembly shall withstand $\Delta p = 1.15\ P_{env}$ and $\Delta p = –0.35\ P_{env}$ without damage.

4.28 Local unlinking test

4.28.1 This section is applicable to *junction boxes* only.

4.28.2 In the scope of Item (4.28), define *local unlinking* as the state of an individual junction box input or output being not linked to the correspondent jumper.

4.28.3 A junction box shall maintain their performance under this TS qualification routine, regardless the existence of local unlinking related to any input or output.

4.28.4 The SUPPLIER shall propose a test to verify that the junction box is in conformity with the requirement of Item (4.28.3).

4.29 Well completion fluids test

4.29.1 This section is only applicable to DEVICES that work in contact with well completion fluids (e.g. CONNECTORS applied in the interface between tubing hanger running tool and shearable riser joint, and in the bottom of tubing hanger-running tool).

4.29.2 The qualification routine shall adopt, as work environment fluid, all the well completion fluids specified by PETROBRAS standards, item 1.4.1.12.

4.29.3 For CONNECTORS applied in the interface between tubing hanger running tool and shearable riser joint, and in the bottom of tubing hanger-running tool, the PETROBRAS TS Item 1.4.1.11 is also applicable.

4.29.4 The manufacturer permitted to propose as representative test fluid the completion fluids listed item 1.4.1.12 for approval by Petrobras.

4.30 Maximum de-mating velocity

4.30.1 Maximum de-mating velocity in the installation environment: 1.5m/s.

4.31 Other requirements

4.31.1 The components of the Electrical System shall be proven to be fully adequate to the operation and storage conditions of the internal and external environments to which they will be subjected during the entire design life, maintaining all the electrical and mechanical functional conditions of their specification.

4.31.2 The metallic and elastomeric componentes of the System shall be suitably and chemically compatible with the various fluids to various which they shall be exposed under ambient operating and storage conditions throughout the design life.

4.31.3 Proof of this requirement for elastomeric components shall be through Qualification Tests in accordance with ISO 23936(parts 1 and 2) and ISO 11346:2004.

5 DOCUMENTATION

5.1 MDP - Master Document Plan.

5.1.1 The MDP shall be provided by SUPPLIER, covering all relevant aspects of the Connector design, qualification, FAT and interface drawings. All documentation must be supplied in digital formats. All documents and drawings shall be provided, at least, in PDF format. Other formats such .DWG may be used as well for drawings.

5.1.2 Copies of all test reports and data taken during testing shall be provided to PETROBRAS. These include assembly and disassembly procedures, technical illustrations and/or instructions, dimensional data, maintenance and safety recommendation, care/storage and handling instruction, special tools and/or fixtures required.

5.1.3 Minimum design documentation to be provided shall be be titled and contain information as described by following documents:

(a) General Arrangement Drawings;
(b) Connector Datasheets;
(c) Qualification Schedule;
(d) Mating Drawings (the Connectors in mating position);
(e) Complete technical description of the Connectors (male and female halves) characteristics and functionalities;
(f) Document List;
(g) Deviation List;
(h) Quality Plan;
(i) Spare Part List;
(j) Component and Equipment List;

5.1.4 The Connector Supplier drawings and documents, submitted to PETROBRAS or its representatives for approval, will not release the Connector Supplier of any responsibility for detailing, dimensional, equipment construction or specifications deviations.

5.2 MANUAL AND DATA BOOK

5.2.1 When all the final drawings and documents are issued and certified, the Connector Supplier shall deliver an organized Manual containing all Connectors and accessories AS BUILT documentation.

5.2.2 This Manual shall include, at least:

(a) All documents in the final technical proposal, item above, in is AS BUILT revision;
(b) The Qualification program test reports (for each Connector part number);
(c) The FAT program test reports (for each Connector serial number);
(d) Assembling procedures;
(e) Test procedures: at surface and subsea.

5.2.3 During the Qualification, EFAT and FAT programs, relevant data shall be requested by PETROBRAS to be included in the Manual.

5.2.4 All documents in the Manual shall be presented for PETROBRAS, at least, 30 days before the Connectors delivery. Afterwards, two electronic (PDF) copies shall be provided.

5.3 RESPONSABILITY AND GUARANTEE

5.3.1 The approval on the part of PETROBRA'S in anyone phase does not exempt or diminishes the total responsibility of the supplier how much the quality, the result and the performance of the product and design during the life for which the Connector is designed.