

Construction, Assembly and Conditioning of Instrumentation

Procedure

This Standard replaces and cancels its previous revision.

The CONTEC - Authoring Subcommittee provides guidance on the interpretation of this Standard when questions arise regarding its contents. The Department of PETROBRAS that uses this Standard is responsible for adopting and applying the sections, subsections and enumerates thereof.

Technical Requirement: A provision established as the most adequate and which shall be used strictly in accordance with this Standard. If a decision is taken not to follow the requirement ("non-conformity" to this Standard) it shall be based on well-founded economic and management reasons, and be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by imperative nature.

Recommended Practice: A provision that may be adopted under the conditions of this Standard, but which admits (and draws attention to) the possibility of there being a more adequate alternative (not written in this Standard) to the particular application. The alternative adopted shall be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by verbs of a nonmandatory nature. It is indicated by the expression: **[Recommended Practice]**.

Copies of the registered "non-conformities" to this Standard that may contribute to the improvement thereof shall be submitted to the CONTEC - Authoring Subcommittee.

Proposed revisions to this Standard shall be submitted to the CONTEC - Authoring Subcommittee, indicating the alphanumeric identification and revision of the Standard, the section, subsection and enumerate to be revised, the proposed text, and technical/economic justification for revision. The proposals are evaluated during the work for alteration of this Standard.

"The present Standard is the exclusive property of PETRÓLEO BRASILEIRO S.A. - PETROBRAS, for internal use in the Company, and any reproduction for external use or disclosure, without previous and express authorization from the owner, will imply an unlawful act pursuant to the relevant legislation through which the applicable responsibilities shall be imputed. External circulation shall be regulated by a specific clause of Secrecy and Confidentiality pursuant to the terms of intellectual and industrial property law."

CONTEC

Comissão de Normalização
Técnica

SC - 10

Instrumentation and Industrial
Automation

Introduction

PETROBRAS Technical Standards are prepared by Working Groups - WG (consisting specialized of Technical Collaborators from Company and its Subsidiaries), are commented by Company Units and its Subsidiaries, are approved by the Authoring Subcommittees - SCs (consisting of technicians from the same specialty, representing the various Company Units and its Subsidiaries), and ratified by the Executive Nucleus (consisting of representatives of the Company Units and its Subsidiaries). A PETROBRAS Technical Standard is subject to revision at any time by its Authoring Subcommittee and shall be reviewed every 5 years to be revalidated, revised or cancelled. PETROBRAS Technical Standards are prepared in accordance with PETROBRAS Technical Standard [N-1](#). For complete information about PETROBRAS Technical Standards see PETROBRAS Technical Standards Catalog.

Summary

Foreword.....	4
1 Scope.....	4
2 Normative References.....	4
3 Terms and Definitions.....	6
4 General Conditions.....	9
4.1 Documentation Requirements.....	9
4.2 Execution Planning Requirements.....	9
4.3 General Technical Requirements.....	10
4.4 Specific Technical Requirements.....	11
4.5 Preservation Requirements.....	13
4.6 Personnel Qualification Requirements.....	13
4.7 Recording Requirements	14
4.8 Health, Safety and Environment Requirements.....	16
5 Receipt and Storage.....	17
5.1 Documentation Requirements.....	17
5.2 General Technical Requirements.....	20
5.3 Specific Technical Requirements.....	20
5.3.1 Receipt.....	20
5.3.2 Storage.....	22
5.4 Records	22
6 Calibration.....	23
6.1 Documentation Requirements.....	23
6.1.1 Calibration Procedure	23
6.1.2 Plan of Issuance and Approval of the Documents.....	24
6.2 General Technical Requirements.....	24
6.2.1 Initial Conditions.....	24
6.2.2 Scope of Calibration.....	25
6.2.3 Environmental Conditions	26
6.2.4 Calibration Method.....	26



6.2.5 Metrology	26
6.3 Specific Technical Requirements	27
6.3.1 Transmitting Instruments	27
6.3.2 Measuring Systems	27
6.3.3 Rearrangement, Command and Control Panels, Insulators, Auxiliary Systems	28
6.3.4 Sensors and Analyzers	28
6.3.5 Motorized, Pneumatic, Hydraulic and Control Valves	28
6.3.6 Safety Valves	29
6.3.7 Rotameters	29
6.4 Records	29
7 Assembly	29
7.1 Documentation Requirements	29
7.2 Execution Planning Requirements	30
7.3 General Technical Requirements	30
7.4 Specific Technical Requirements	31
7.4.1 Conduits, Raceways and Trays	31
7.4.2 Cables and Multicables	32
7.4.3 Tubing	33
7.4.4 Instruments and Junction Boxes	34
7.5 Records	34
8 Conditioning	34
8.1 Documentation Requirements	35
8.2 General Technical Requirements for Tests and Trials	36
8.3 Specific Technical Requirements for Tests and Trials	37
8.3.1 Pneumatic and Hydrostatic Testing	37
8.3.2 Tightness Test in Connections	38
8.3.3 Insulation Strength Test	39
8.3.4 Continuity Test on Contacts & Cables	40
8.3.5 Loop Test	40
8.3.6 Tests on Optical Fibers	41
8.4 Records	41

Foreword

This Standard is the English version (issued in 07/2013) of PETROBRAS N-858 REV. D 09/2011, including its Amendment - 07/2013. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

1 Scope

1.1 This Standard establishes the requirements for construction, assembly and conditioning for systems of instrumentation, control and automation, including receipt, storage, conservation, assembly, testing and calibration of instruments and accessories.

1.2 This Standard applies to the following systems or instruments:

- a) systems for analysis, measurement, transmission and control of process variables;
- b) systems for industrial networks, Distributed Digital Control System (SDCD) and CP (Programmable Controllers);
- c) control valves, safety valves, analyzers, detectors and panels;
- d) supply systems for power, in-line measurement and in-line mixture.

1.3 This Standard applies to procedures started as of their issuance date.

1.4 This Standard contains Technical Requirements and Recommended Practices.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

CNEN - [NE-3.02](#) - Serviços de Radioproteção;

CNEN - [NE-5.01](#) - Transporte de Materiais Radioativos;

CNEN - [NN 3.01](#) - Diretrizes Básicas de Proteção Radiológica;

INMETRO - [NIT-DICLA-021](#) - Expressão da Incerteza de Medição;

Norma Regulamentadora nº 10 ([NR-10](#)) - Segurança em Instalações e Serviços em Eletricidade;

Norma Regulamentadora nº 13 ([NR-13](#)) - Caldeiras e Vasos de Pressão;

Norma Regulamentadora nº 17 ([NR-17](#)) – Ergonomia;

Norma Regulamentadora nº 26 ([NR-26](#)) - Sinalização e Segurança;

Portaria INMETRO [MDIC Nº 179/2009](#) - Requisitos de Avaliação da Conformidade para Equipamentos Elétricos e Eletrônicos para Atmosferas Explosivas;

Resolução [CONMETRO Nº 12](#) - Regulamentação Metrológica e Quadro Geral de Unidades de Medida;

PETROBRAS [N-76](#) - Materiais de Tubulação para Instalações de Refino e Transporte;

PETROBRAS [N-115](#) - Fabricação e Montagem de Tubulações Metálicas;

PETROBRAS [N-1591](#) - Metal Alloys and Metals - Identification by Magnet and Spot Testing;

PETROBRAS [N-1592](#) - Non-Destructive Testing - Identification of Materials;

PETROBRAS [N-1882](#) - Criteria for Development of Instrumentation Designs;

PETROBRAS [N-1931](#) - Instrumentation Piping Materials;

PETROBRAS [N-1997](#) - Electrical Networks in Cable Tray Systems - Design, Installation, and Inspection;

PETROBRAS [N-2033](#) - Inspeção de Fabricação - Qualificação de Pessoal;

PETROBRAS [N-2162](#) - Work Permit;

PETROBRAS [N-2368](#) - Inspeção, Manutenção, Calibração e Teste de Válvulas de Segurança e/ou Alívio;

PETROBRAS [N-2791](#) - Detalhes de Instalação de Instrumentos ao Processo;

ABNT [NBR 5426](#) - Planos de Amostragem e Procedimentos na Inspeção por Atributos;

ABNT [NBR 10300](#) - Cabos de Instrumentação com Isolação Extrudada de PE ou PVC para Tensões até 300 V;

ABNT [NBR 13881](#) - Termômetros Bimetálicos - Recomendações de Fabricação e Uso - Terminologia, Segurança e Calibração;

ABNT [NBR 14105-1](#) - Medidores de Pressão - Parte 1: Medidores Analógicos de Pressão com Sensor de Elemento Elástico - Requisitos de Fabricação, Classificação e Utilização;

ABNT [NBR IEC 60079-14](#) - Atmosferas Explosivas - Parte 14: Projeto, Seleção e Montagem de Instalações Elétricas;

ABNT [NBR IEC 60079-17](#) - Atmosferas Explosivas - Parte 17: Inspeção e manutenção de instalações elétricas;

ABNT [NBR IEC 60529](#) - Graus de Proteção para Invólucros de Equipamentos Elétricos (Código IP);

ABNT [NBR ISO 9000](#) - Sistemas de Gestão da Qualidade - Fundamentos e Vocabulário;

ABNT [NBR ISO 9001](#) - Sistemas de Gestão da Qualidade;

ABNT [NBR ISO/IEC 17025](#) - Requisitos Gerais para a Competência de Laboratórios de Ensaio e Calibração;

API [RP 520 Part II](#) - Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries Part II - Installation;

API [STD 600](#) - Steel Gate Valves - Flanged and Butt-welding Ends, Bolted Bonnets;

ASME [B16.5](#) - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard;

IEC [62337](#) - Commissioning of Electrical, Instrumentation and Control Systems in the Process Industry - Specific Phases and Milestones;

IEC [62381](#) - Automation Systems in the Process Industry - Factory Acceptance Test (FAT), Site Acceptance Test (SAT), and Site Integration Test (SIT);

IEC [62382](#) - Electrical and Instrumentation Loop Check.



NOTE For documents referred in this Standard and for which only the Portuguese version is available, the PETROBRAS department that uses this Standard should be consulted for any information required for the specific application.

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1

ANP - National Agency of Petroleum, Oil, Natural Gas and Biofuels

federal government agency which rules on oil, by-products and biofuels

3.2

intentional connection for grounding

intentional electrical continuity between the various metal components and the grounding grid. Examples of items or components which may not be used for this purpose: bolts, clamps and conduits

3.3

conditioning

set of preparation activities for energizing and operation on all grids and commissionable items, operating systems and subsystems undertaken with the purpose of leading them to the Pre-operation & Start-up phase, aiming at the Certification of Mechanical Completion

3.4

intentional electrical continuity

means designed and implemented with the purpose of maintaining the electrical continuity. Examples of means that may be used to provide electrical continuity: wires, connectors, terminals, copper metal bars and welding. Bolts and clamps do not guarantee the electrical continuity between the metal parts

3.5

Probable Total Error - PTE

maximum expected error for the instrument, when submitted to usable conditions which differ from those deemed as reference on its calibration and/or reported by the manufacturer, in accordance with Annex A of PETROBRAS [N-1882](#)

3.6

commissioning

structured set of information, practices, procedures and capacities which are applicable, in an integrated manner, to an installation, in order to make it operational within the desired performance requirements, which main objective is to ensure that the installation is transferred from the assembler to the Operating Unit quickly, orderly and safely, ensuring its operability in terms of performance, reliability and traceability of information

3.7

prototype approval tests

test performed on equipment under development or equipment to which type-approval does not apply. The following tests may be mentioned: structure hardness, pressurization test for Ex "p" panels and type tests for electrical equipment

3.8

check sheets

set of forms which are integrated to the commissioning management system

3.9

Item Check Sheet (ICS)

record of the Activities Management System, which aims to control and identify the characteristics of each item to be commissioned

3.10

Grid Check Sheet (GCS)

diagram-shaped record of the Activities Management System, used in the pre-operation phase, to control and execute the piping's hydrostatic tests (piping grids), "blank tests" (electric grids) and "loop tests" (instrumentation grids)

3.11

dimensional inspection

set of direct measurement activities in finished or semi-finished products in the main dimensions and measurements using measuring instruments

3.12

final Inspection

check performed to certify the correct execution of activities preceding the transfer of the commissioned item to another in charge of the custody and control of the item, completing a step

3.13

visual inspection

check performed in finished or semi-finished parts using only visual or facilitator resources such as: light fixtures, magnifying glasses and mirrors; opening of panels and terminal boxes

3.14

sampling plan

document prepared by the assembler, based on the specific quality requirements which define the types of material or equipment that shall be checked, and how the sample is supposed to be collected, as well as the Acceptable Quality Level (AQL)

3.15

Inspection and Test Plan (ITP)

document defining, for a specific equipment, which inspection steps shall be performed during manufacturing or assembly, the reference standards for inspection and construction, the acceptance criteria for tests, as well as any relevant comment to facilitate inspection

3.16

traceability

requirement, defined contractually which documents shall be provided with the equipment, including type tests and routine for certification. It is divided into levels, which may be: Total Traceability (TT), Limited Traceability (LT) or without traceability

3.17

Limited Traceability (LT)

traceability limited to the commissioning period

3.18

Total Traceability (TT)

correlation between raw materials and their key data, such as examinations, tests, run and validity. It covers all the range between raw materials and finished product, intended for usage at any time and kept for the entire equipment's lifecycle

3.19

contract quality requirement

document included in the construction and assembly contract, which defines the managerial and technical requirements which must be accomplished, such as: qualification of performers, specifications, applicable standards and traceability

3.20

standard control system

system which controls the validity of the various instruments used in calibration, assembly and tests. It includes tags fixed on the instruments and other records

3.21

activities management system

a generally computer-based system which aims to control, map, monitor and record the commissioning activities, as well as the planned conditioning activities such as tests, . providing means to monitor and manage the whole construction and assembly process. It comprises several disciplines and, regarding instrumentation, all instruments and instrumentation systems are included, as well as their tests planned in the Inspection and Tests Plan (PIT), the execution and the report which is relevant to each activity. These tools include the Integration and Commissioning Tool (FIC) and the Management and Commissioning System (SGC)

3.22

Operating System (SOP)

integrated set of equipment, grids, instruments and other properly associated installations, capable of performing a productive function or process-supportive function, whose operation produces or maintains a specific situation, process, utility, or operating facility in a safe condition

3.23

continuity test

electrical test performed on on/off switches and wires in order to check whether the equipment or component carries electricity properly

3.24

electrical tests

tests applied to electrical equipment in order to check proper operation

3.25

functional and performance testing

tests performed on equipment in order to check its set condition or its individual performance when it is put into operation

3.26**mechanical tests**

tests performed on materials in order to check their mechanical characteristics, such as: traction, bending, impact, hardness, bolt-tightening torque, valve-opening torque, mechanical operation, post-operation wear, valve sealing class, valve opening/closing test (time, position when failed)

3.27**test by points**

test with chemical reagents applied to metals for recognition of its composition

3.28**structural strength tests**

tests performed in order to check if what was manufactured or assembled withstands the operating conditions. These tests include: hydrostatic, pneumatic, tightness in parts joined by flanges, unions, welding and threads

3.29**Insulation strength test**

electrical test performed in components or equipment in order to check if they are integral and support the voltages

3.30**mechanical strength test**

hydrostatic or pneumatic test performed in components or equipment in order to check if they are integral and able to support the design pressure conditions

3.31**SAP R3**

Integrated Management System used by PETROBRAS

4 General Conditions

The topics below are applicable to every step of construction, assembly and conditioning of instruments and instrumentation systems.

4.1 Documentation Requirements

A Sampling Plan shall be prepared in accordance with the Quality Contract Annex, describing the required instruments/equipment plan, the qualified personnel for the tests and the stage in which they shall be required, considering their respective deadlines for availability.

4.2 Execution Planning Requirements

4.2.1 In order to perform instrumentation activities in a comprehensive and planned manner, there must be the implementation, by the contractor, of an Activities Management System which includes the instrumentation, and which must manage all activities planned since the arrival of the instruments, materials and instrumentation systems, up to the phase of commissioning and preparation for operation and start-up. This system shall be submitted for approval from PETROBRAS.

4.2.2 This system shall contain a list with all instruments, materials to be received, packaged, assembled and integrated, and a forecast with points to be inspected by the contractor and by PETROBRAS could be included in this system. This Inspection and Tests Plan (PIT) must contain the various activities planned as mandatory inspection points. The PIT may be integrated to the Activities Management System.

4.2.3 The information about the contractually required types of factory inspection and traceability class must be included in this system as relevant information to guide the work.

4.2.4 When there is a requirement for tests and/or trials, their respective reports shall be updated in the Activities Management System in the time planned so as not to impact the subsequent activities.

4.2.5 The information stored in the database, whether they are from management of activities, calibration or other, shall be protected against changes by unauthorized people, recording what was changed, when, by whom and who authorized it. It is recommended that these systems are computer-based. **[Recommended Practice]**

4.3 General Technical Requirements

4.3.1 The required machinery, equipment and tools must be available and in proper working conditions.

4.3.2 Possible deviations for items which are planned and not executed shall be addressed with supervision, such as: tests which shall not be carried out for various reasons. In these cases, the previous situation and the current one shall be recorded. This record shall be referenced in the Activities Management System and may be done so as a non-compliance report, as a meeting minute or as a record in the Daily Report of the Work (RDO).

4.3.3 In order to record the values measured during calibration, trials and tests, the significant digits shall be reconciled for the values obtained in accordance with the resolution of the standard used.

4.3.4 The values must be recorded using the International Units System (SI), in accordance with CONMETRO Resolution nº 12. If necessary, other engineering unit might be referenced.

4.3.5 The instruments, materials and equipment to be applied in potentially explosive areas must be sent with the compliance certificate, in accordance with INMETRO's MDIC Ordinance nr. 179/2009 and ABNT [NBR IEC 60079-14](#) and [NBR IEC 60079-17](#). Examples: wire rope grips, junction boxes, instruments housing, panels, etc. This certification must be checked upon receipt, calibration and assembly.

4.3.6 The instruments, materials and equipment to be applied in areas which require certification related to levels of protection for housings of electrical equipment (IP Code) must be sent with the compliance certificate, in accordance with ABNT [NBR IEC 60529](#) and provided on PETROBRAS [N-1882](#).

4.3.7 Certificates and reports of trials and tests performed during manufacturing shall also be sent along with instrumentation, automation systems and instrumentation materials. These certificates must be analyzed as to its calibration and material specifications, as well as if they allow traceability, as mentioned in the quality contract annex.

4.3.8 Each and every instrument, equipment and/or system with special requirements for assembly, testing and conditioning must have a specific procedure necessary to its execution previously approved by PETROBRAS.

4.3.9 When not indicated in the design or not provided along with the instruments, equipment and systems, the consumables for tests, temporary cleaning kits, initial loads for calibration and reference shall be supplied by the assembling party.

4.3.10 All instrumented systems and instruments shall be inspected in accordance with ABNT [NBR IEC 60079-17](#) Inspection and maintenance of electrical installations in classified areas. In case of renovation or of construction and assembly of a new unit, the required inspection is the “detailed” inspection. The “visual” and “monitored” inspection modes of this ABNT standard do not apply to this item.

4.4 Specific Technical Requirements

4.4.1 Every event record must show their respective satisfactory completion date, in addition to the following relevant information:

- a) receipt:
 - type of factory inspection;
 - number of the report of inspection at receipt;
- b) storage: exact storage location of the respective material;
- c) assembly (completed events recorded in proper documents):
 - support;
 - assembly of the instrument;
 - impulse line;
 - hydraulic / pneumatic / power supply;
- d) conditioning:
 - number of the non-compliance report;
 - number of the hydrostatic tests report;
 - number of the pneumatic tests report;
 - number of the electrical tests report;
 - number of the calibration and bench test certificate;
 - preservation: date of last and next preservation.

4.4.2 The creation of a folder in a physical or electronic media shall be contemplated, comprising the documents mentioned in 4.4.1 of the documents received from manufacturing, as required in a contract annex as of LT or TT.

4.4.3 Where applicable, the services covered by this Standard, which relate to the techniques of assembly, integration, testing and instrumentation materials shall be performed according to specific procedures established by the executing party and under prior approval by PETROBRAS; especially if they impact quality, operability, operation stability, health, safety and environment. These specific procedures include:

- a) receipt and storage of instruments, materials and instrumentation equipment;
- b) assembly of instruments, panels and instrumentation materials;
- c) conditioning of instruments and instrumentation systems:
 - structural strength tests;

- mechanical tests;
- electrical tests;
- prototype approval tests;
- performance and functional tests;
- sampling plan;
- preservation;
- other relevant measurements.

4.4.4 From now on in this Standard, specifics are mentioned for each of these tests and for the basic parameters of each test type and which shall also be mentioned in their respective procedures.

4.4.5 The procedures provided for the activities covered by this standard shall reference the activities required by the Activities Management System, as well as to provide sheets, work cards and forms which comply with the Activities Management System, including as to the qualification issues for the execution specified by the quality contract annexes.

4.4.6 The clear identification of the inspector, as well as his/her signature on the records and the durability of these records and signatures, even when subject to harsh location conditions, are key requirements for the correct certification of its execution.

4.4.7 The standard instruments used in measurements, tests and calibration must be controlled by the calibration control system, must have a tag showing the expiration date, must be within the validity period and must be in proper usage conditions, in accordance with the quality requirements on ABNT [NBR ISO 9001](#).

4.4.8 The maximum tolerated error shall be checked by applying the most restrictive among the project definitions, legal requirements, contract standards and manufacturer specifications.

NOTE PETROBRAS [N-1882](#) establishes, in 9.1.4, the accuracy, when required by the basic process project.

4.4.9 The standard instrument to be used shall be calibrated and have its uncertainty, for the range in which the instrument to be calibrated will be used, of, at least, one third of of the one determined by the constructive standard of the instrument or manufacturer's specification of the instrument to be calibrated.

4.4.10 When the standard instrument has systematic errors which influence the aforementioned relationship, these errors shall be corrected. They shall be corrected by maintaining the standard instrument or, if agreed with inspection, correcting the mathematics of the values.

4.4.11 Maintenance of a process or standard instrument incurs the need for recalibration.

4.4.12 The electronic cards are susceptible to damage caused by static electricity, humidity, and high or low temperature. When handling the electronic cards, one shall use protective equipment which dissipates static electricity and adopt measures to protect them from other ways of causing damage.

4.5 Preservation Requirements

4.5.1 Prior to the receipt inspection, in order to facilitate the planned checks, a form of preservation that does not damage the material, instrument or instrumentation equipment shall be determined in accordance with its manufacturing warranty.

4.5.2 Initial preservation shall be that of the manufacturer, and the others are those required under the Activities Management System, including those regarding periodicity.

4.5.3 Flanges of instruments and valves, as well as orifices and holes in enclosures, panels, conduits, among others, shall be plugged so as to prevent entry of dust, humidity and insects.

4.5.4 When handling electronic cards, protective equipment which dissipates static energy shall be used and preserved using the anti-static packaging.

4.5.5 In any activity where improper exposure of the equipment or part of it to bad weather may occur, protective measures such as an assembly of temporary structures with canvas shall be adopted.

4.6 Personnel Qualification Requirements

4.6.1 Each and every activity of construction, assembly and instrumentation conditioning shall be performed by qualified professionals, in accordance with what is determined in the Quality Contract annex.

4.6.2 The entire staff of construction, assembly and instrumentation conditioning shall undergo an additional training specific to the performance of the position, aiming to standardize the work methodology, ensuring the correct application of procedures and the standardization of generated records.

4.6.3 The manufacturing inspection activities shall be performed by certified professionals according to PETROBRAS [N 2033](#), as defined in the Quality Contract annex.

4.6.4 The professionals in charge of technical coordination/supervision activities, root cause analysis and corrective actions related to instrumentation shall have their résumés submitted for PETROBRAS approval.

4.6.5 The activities of calibration, report generation and management of results required in the procedures shall be monitored and checked by a qualified/certified inspector. When the provided (legal or contractual) requirement does not require its execution by a qualified/certified professional, he/she shall have their capacity proven by ways of résumés or another method of evaluating practical knowledge.

4.6.6 The entire staff of calibration supervision and execution shall undergo specific training for the performance of their position, aiming to standardize the work methodology, ensuring the correct application of the calibration procedures.

4.6.7 According to ABNT [NBR ISO 9000](#), for corrective actions, in root cause analysis, the professionals involved shall be specialized technicians or engineers.

4.6.8 It is suggested that the staff of assembly of instruments, analysis and automation systems be divided into: electro-electronics staff and mechanical staff, with the following responsibilities.
[Recommended Practice]

- a) electro-electronics staff: personnel in charge of assembling, testing and conditioning of all the electrical and electronic instrumentation and automation subsystems, as well as setting cable routing, panels, junction boxes, laying and connection of cables in the various subsystems, panels and instruments and other components, including those of industrial networks
- b) mechanics staff: personnel in charge of assembling, testing and conditioning of all instrumentation mechanical subsystems, as well as manufacturing supports for instruments, panels, cable routing media; assembly of electrical outlets and routing of impulse lines for instruments and analysis system; distribution of instrument air, welding, painting and others.

4.6.9 The conditioning activities required in ITP shall be monitored and checked by a qualified/certified inspector. When the provided (legal or contractual) requirement does not require its execution by a qualified/certified professional, he/she shall have their capacity proven by ways of *résumés* or another method of evaluating practical knowledge.

4.6.10 Training for the staff of conditioning supervision and execution shall be provided and implemented, allowing all those involved to be aware of the necessary documents for this phase, and its correct application.

4.7 Recording Requirements

4.7.1 Every task detailed in the assembly and construction planning, and by the Activities Management System such as the electrical, mechanical and structural strength tests shall provide its execution record in specific forms, produced by the assembling party.

4.7.2 The forms mentioned in 4.7.1 shall have the fields described below, where applicable, and must be completed during the performance of the activities:

4.7.2.1 Tagging

- unambiguous tagging of the instrument, equipment and/or system;
- reference document, such as: plant, typical detail, suppliers manual;
- SOP and sub-SOP to which the services are submitted;
- number and revision of the activity's execution procedure.

4.7.2.2 Task Description

The task description shall be as required in the Activities Management System.

4.7.2.3 Necessary resources:

- utilities and instruments to be used in the tests;
- material resources and special tools to be used;
- human resources and personnel qualification,

— consumables and temporary materials.

4.7.2.4 Task Description

- execution sequence, brief description;
- special conditions to be observed.

4.7.2.5 Identification of Performers and Monitors (Name and Signature)

- in charge of execution;
- in charge of verification ;
- Safety Technician;
- identification of PETROBRAS' Supervisor in charge of approving the activity.

4.7.2.6 Test Execution

- execution sequence, brief description;
- variable to be applied;
- foreseen time of application;
- expected values.

4.7.2.7 Test Results

- Fluid used;
- elapsed time of application;
- instruments used, including the expiration date of the calibration;
- yielded values;
- acceptance criteria;
- report of acceptance or rejection.

4.7.3 The records of the required activities shall be generated in compliance with this Standard and with the certified procedures. These shall faithfully reflect what is observed regarding what is required in the procedure. For items with the “non-compliance” report, an action shall be taken such as the opening of “non-compliance” record. For “not applicable” items, if it is not clearly an item that the equipment does not need or which is not part of the equipment, the dealings must have been agreed with the PETROBRAS.

4.7.4 Every non-compliance shall have a record describing it completely, including evidences and mentioning unfulfilled legal, contractual or regulatory requirements. The processing and control of this non-compliance record shall be as required in the quality manual and be exclusive, even for subcontractors.

4.7.5 The records of pending items and non-compliances issued must be traceable by the Activities Management System.

4.7.6 Every correction, preventive action or proposed corrective action shall be submitted for evaluation and approval of the engineer /technician in charge.

4.7.7 Any record shall contain the required tests and trials which were left pending, as well as in which phase its performance shall be provided. These shall only be permanently considered technically acceptable after completion with the approval of these tests and trials.

4.7.8 Every internal inspection and external audit shall be recorded, as well as the findings of the audits and the actions taken to eliminate the deviations.

4.7.9 For activities controlled in databases such as the Activities Management System, the records must be updated in a timely manner, preferably before the start of the next phase.

4.7.10 In case of execution of non-destructive test for recognition of metals and alloys, the results shall be recorded in accordance with PETROBRAS [N-1591](#).

4.7.11 A record shall be issued, proving the execution of the detailed initial inspection or another one required by ABNT [NBR IEC 60079-17](#). This record shall integrate the loop report, while the set of loop reports shall integrate the plant report.

4.7.12 The record set shall be part of the final quality-proving document for all grid components and shall be the basis for the next phase of the work which could be commissioning and pre-operation.

4.8 Health, Safety and Environment Requirements

4.8.1 For every activity, the Personal Protective Equipment (PPEs) required for execution of services of receipt, storage, calibration, inspection and tests required shall be defined in procedures. Those involved in the tests shall wear a PPE in accordance with the definition in the safety and operational procedure(s) required for the type of activity to be performed.

4.8.2 Every staff, whether they are of receipt, calibration, tests, assembly, commissioning and conditioning shall be trained and made aware to the appropriate disposal of generated residue, complying with the legal requirements or operational procedures of the area where they are generated.

4.8.3 All other aspects of environmental risks and impacts present in activities of instrumentation receipt and storage shall be considered.

4.8.4 Where applicable, the issuance of the work permit shall be checked in accordance with PETROBRAS [N-2162](#) and, in case of non-compliance, it shall be reported to the Industrial Safety Agency.

4.8.5 The traffic and access ways in the receiving and storage locations shall be clearly marked and shall allow free passage of equipment and cargo handling.

4.8.6 The location where the receiving tasks are executed shall have appropriate ergonomic conditions, including lighting, furniture, temperature, etc., in accordance with [NR-17](#).

4.8.7 Safety signs and equipment intended for collective protection such as hoses, hydrants and sprinklers shall not be obstructed, in accordance with [NR-26](#).

NOTE The Regulatory Standards (RSs) of the Ministry of Labor and Employment and all other legislative aspects shall be complied with.

4.8.8 If fluids are used in the controlled temperature thermal baths, these shall be selected so as not to cause problems regarding the safety and the operability of baths and users. The installation and usage of thermal baths shall be carefully planned, installed and operated so as to prevent incidents and accidents.

4.8.9 Preferably, the occupational safety agency shall evaluate the installation and the usage.
[Recommended Practice]

4.8.10 When energized systems such as pressurized, heated, and electrified systems are being used, the adjacent area shall be isolated, preventing the presence of those who are not directly involved in these activities.

4.8.11 When an equipment is energized (e.g.: heating elements; automatically-activated mechanical equipment), appropriate measures shall be taken to prevent possible accidents such as isolating access and posting warning signs on the equipment.

4.8.12 Activities with electricity, whether they are in calibration, tests, conditioning, construction and assembly of equipment, shall be performed by professionals in accordance with [NR-10](#).

4.8.13 All personnel shall be qualified to the work intended, in accordance with the Regulatory Standards of the Ministry of Labor and Employment, as to the safety conditions, as well as to the certification of specific professionals, such as: welders, electricians, safety technicians and Technician in Charge.

4.8.14 The services to be performed shall be previously evaluated and, depending on the risk and the degree of difficulty of its execution, special conditions and equipment shall be required in order to ensure the integrity of the performer, such as: overhead services, services in confined spaces, services in operating equipment.

4.8.15 The assembly staffs shall be composed of professional technicians and/or supervisors trained and capable of requesting Work Permit (WPs), as well as participating in Preliminary Risk Analysis (PRAs), aiming to minimize the risks involved in the execution of the task.

4.8.16 For every activity, the PPEs required for execution of services of receipt, calibration, inspection and tests required shall be defined in procedures and those involved in the test procedures shall wear a PPE in accordance with the definition in the safety and operational procedure(s) required for the type of activity to be performed.

5 Receipt and Storage

Receipt and storage are part of the activities required by the Activities Management System as conditioning.

5.1 Documentation Requirements

During the receipt activity, the contractual requirements regarding the degree of inspection and the traceability extension defined for each type of material or equipment shall be available for consultation.

5.1.1 The performer's receipt and storage procedure shall be prepared in accordance with the design documents, with this Standard and with the following additional information for each type of equipment:

- instructions for unpacking;
- instructions for receipt inspection;
- Instruction for checking of spare parts and accessories;
- instructions for protection and initial preservation;
- storage instructions;

5.1.2 The instructions for initial inspection shall provide quantitative assessment of all received material based on the purchase documents.

5.1.3 The receipt procedure shall provide for the application of qualitative inspection of equipment and instruments, and shall guide the activities of document analysis, visual inspection, dimensional inspection and applicable tests, also in order to comply with the work's conditioning and commissioning topics.

5.1.4 For materials or equipment with TT or LT requirement, the documents (certificates, manufacturer's records, inspection reports, manuals etc.) to be checked on receipt shall be informed. Record the check on the receipt report.

5.1.5 The receipt and storage procedure shall reference a Receipt Inspection Report (RIR), which shall be completed for each performed inspection. This report shall contain checks required in the Activities Management System such as documentary records and their analysis; visual inspection; dimensional inspection; applicable tests and report.

5.1.6 In case of discrepancy or additional information, there shall be the provision, in the receipt and storage procedure, of records of additional documents such as a reference to a non-compliance report or to a field-test report.

5.1.7 The receipt procedure shall contemplate the compliance check of received materials and equipment regarding the design specifications. This compliance check shall be less strict when the material has been inspected during manufacturing, and more thorough in equipment and instruments which were not inspected during manufacturing, in compliance with the traceability requirements under the contract annex.

5.1.8 The receipt procedure for every material, equipment, system and instrument shall provide for the checking of damage due to improper shipping, handling or storage and the measures to be adopted.

5.1.9 The storage procedure for materials and equipment shall determine the storage location in compliance with the manufacturers' recommendations. The contractor shall keep records showing the manufacturer's recommendation (equipment manual, supplier's report).

5.1.10 The technical description of storage location required in the procedure shall be appropriate to the area in which it shall be assembled. Variations may be accepted in case they are addressed with PETROBRAS. Analyses of these variations aim to comply with the local weather conditions in order to be appropriate to each area, but shall suitably preserve the instruments and instrumentation materials, regardless of area. Manufacturers' recommendations have to be analyzed in this context. These variations and data analysis of manufacturers shall be recorded.

5.1.11 The storage locations required in the procedure are defined as “A”, “B” and “C” as described below.

- Type A: indoor storage, in a location with paved flooring, controlled temperature between 20 °C and 30 °C and controlled humidity below 80 %;
- Type B: indoor storage, in a location with a paved flooring, without humidity and temperature control;
- Type C: outdoor storage on a steady, leveled ground, in locations which are not prone to flooding, supported by pallets in order to avoid direct contact with the ground.

5.1.12 In case there is no specific recommendation; the appropriate location type shall be defined in accordance with 5.1.12.1 to 5.1.12.3.

5.1.12.1 Type “A” Storage Location

The procedure shall provide storage for the equipment and instruments listed below, or those with the same complexity:

- micro-processed and electronic systems and instrumentation for indoor applications;
- emergency power supplies;
- detectors;
- analyzers;
- mineral insulating thermocouple.

5.1.12.2 Type “B” Storage Location

The procedure shall provide storage for the equipment and instruments listed below, or those with the same complexity:

- field instrumentation;
- inverters, rectifiers and solid state switches;
- batteries;
- orifice plates and restriction orifices;
- orifice flanges;
- rupture discs;
- local panels;
- “skid” assembled systems;
- accessories;
- junction boxes;
- flexible conduits;
- compression fitting;
- joints;
- bolts and nuts;
- “Multi Cable Transit” (MCT) transition devices;
- push buttons;
- conduit fittings;
- pipe fittings;
- flanges.

5.1.12.3 Type “C” Storage Location

The procedure shall provide for storage of the equipment and instruments listed below, or of those with the same complexity:

- cables, extension cords and multi-cables (housed with plastic canvas);
- rigid conduits (with mechanical and anti-corrosive protection in the thread);
- Raceways, trays, stands and accessories;

- plastic and flexible pipes (“tubing”);
- general supports, stands or holders;
- control valves.

5.1.13 The receipt and storage procedure shall provide for the use of the sampling-by-inspection technique, as required in the quality contract annex, and shall comply with the conditions established in ABNT [NBR 5426](#) and those correlated.

5.2 General Technical Requirements

5.2.1 The instrumentation Receipt and Storage activities shall be performed in compliance with this Standard and with the certified design documents and procedures.

5.2.2 When necessary, the operation of unpacking materials and equipment shall be performed with appropriate tools and methods.

5.2.3 On the receipt inspection, compliance with the materials and equipment received regarding the design specifications shall be checked.

5.2.4 The Material Approval Certificate (MAC) or other document with the same purpose, issued by the inspection agency of the purchaser at the end of the factory acceptance tests shall be checked during receipt, except for materials and equipment which were not inspected at the factory. This exception shall be recorded.

5.2.5 The evidences that every stage was completed under the ITP of the instrument/equipment shall be checked. Eventual pending items shall be assessed and recorded at the receipt phase.

5.2.6 Materials and equipment received shall be free from corrosion, humidity or mechanical damage.

5.3 Specific Technical Requirements

5.3.1 Receipt

5.3.1.1 As a general rule, compliance with the requirements listed below shall be evaluated during receipt inspection, when applicable:

- compliance of nameplates and data;
- equipment or material model/type;
- raw material requirements;
- main dimensions;
- type and dimensions of connections;
- pressure class;
- temperature class;
- degree of protection;
- suitability for application in classified areas (marking);
- painting, coating and finishing requirements;
- suitability to process conditions;
- suitability to environmental conditions;
- sensor type and measurement instruments metrological characteristics;
- other requirements relevant to the intended application.

5.3.1.2 On inspection for receipt of electrical wires, the marking check on the nameplate and the insulation strength test apply as of the receipt, both according to ABNT [NBR 10300](#) and continuity test.

5.3.1.3 Gaskets, bolts, nuts, fittings for piping, flanges, pipes and valves shall be inspected in accordance with PETROBRAS [N-115](#) or [N-1931](#).

5.3.1.4 It shall be checked if, during transportation, there was no detachments of elements within the panels.

5.3.1.5 Field instruments shall be sent with calibration certificates which comply with the contractual requirements of metrological traceability.

5.3.1.6 Instruments intended for tax measurement shall comply with ANP's (National Agency of Petroleum) requirements such as details which infer in the measurement, due to assembly, dimensions and main characteristics, especially those regarding calibration certification.

5.3.1.7 For equipment to which traceability along INMETRO is enough, the manufacturer may choose from calibration and issuance of certificate using a proper standard, traceable to the Brazilian Calibration Network. In this case, it shall be sent with a copy of the calibration certificate of the standards used, in addition to the calibration requirements in ABNT [NBR ISO/IEC 17025](#) such as lab conditions, calculation of errors and uncertainty.

5.3.1.8 Radioactive-type level gauges shall comply with the requirements in CNEN - [NN 3.01](#), [NE-3.02](#) and [NE-5.01](#), as well as the radio protection plan and the unit's specific procedures.

5.3.1.9 Flow meters to which field calibration is not possible, such as those with positive displacement, coriolis, magnetic and turbine shall be sent with calibration certificates, complying with what is required regarding traceability.

5.3.1.10 Flanged control valves, even when they are inspected at the factory, shall have their flange dimensions checked in accordance with ASME [B16.5](#), distance between flanges and height of the actuator.

5.3.1.11 The material the internal parts and the body of the special-alloy control valves are made of shall be tested by a metal alloy recognition test. When inspection is not possible without disassembly, it shall be addressed with supervision, and a way to comply with the metal alloy recognition test may be the sampling inspection. The points test is suggested according to PETROBRAS [N-1591](#) and [N-1592](#), respectively, or the alloy identifier by radiation.

5.3.1.12 The hardness test certificates of the internal parts of the specially coated valves must comply with API [STD 600](#).

5.3.1.13 Industrial network cables shall be checked for its class and certification.

5.3.1.14 Industrial networks' accessories shall be checked for certification, including for patch-panel and non-metal trays.

5.3.2 Storage

5.3.2.1 Preferably, store materials and equipment in the original manufacturer's packaging. If not possible, the package used shall preserve the integrity of the material used. **[Recommended Practice]**

5.3.2.2 For non-compliant material, identification and segregation in a properly marked location shall be provided so as to prevent it from being accidentally used.

5.3.2.3 When required, equipment and materials stored in a type "C" location shall be protected by a plastic canvas covering or by other appropriate means so as to prevent water from penetrating, light from entering and with ventilation in order to dissipate humidity. Additional measures shall be taken to prevent the formation of a favorable environment for the emergence of insect larvae.

5.3.2.4 Equipment and materials stored in a type "B" location, in places where there is dust and other contaminants, shall be protected by a plastic canvas covering or by other appropriate means.

5.3.2.5 The installation of devices or materials to prevent the approach of animals that may affect the quality of the material during storage shall be provided, such as raticides, insecticides, and screens which prevent birds from entering.

5.3.2.6 Materials shall be stored away from walls and pillars of the storage location.

5.3.2.7 The orifice plates shall be stored upright and protected against damage to the surface and the inner edges.

5.3.2.8 The orifice flanges shall be stored with their sides protected and to their respective pairs.

5.4 Records

5.4.1 For every received material, at least three records shall be generated: a RIR, a receipt tag and an update in the Activities Management System.

5.4.2 The receipt tag to be attached to the received material shall have the RIR summary, listing its number, date, final report of the receipt, approving or disapproving the equipment and identifying the performer.

5.4.3 The generated RIR shall be filed along the received compliance documents.

6 Calibration

Calibration is a performance test and is part of the activities required in the Activities Management System as conditioning.

6.1 Documentation Requirements

6.1.1 Calibration Procedure

6.1.1.1 The calibration procedure shall reference a calibration certificate or report which must be completed for each performed calibration. This report shall anticipate the analysis of the topics of activities of document analysis, measurements and report.

6.1.1.2 In case of any discrepancy or additional information, this report shall provide records of additional documents such as references to a non-compliance report or to an on-field test report, etc.

6.1.1.3 The calibration certificates of the instruments shall be prepared in accordance with the design documents and with this Standard, and shall include the minimum provided general content and the following additional information, wherever necessary:

- instruments specifications;
- conditions and abnormalities observed on visual inspection;
- calibration tables for measurements to be performed;
- instructions for opening the monitoring reports in record and management systems such as MCS, ICT and SAP R3;
- references to the procedure and other documents in paper or electronic media;
- reference to the used standards traced by Brazilian Calibration Network;
- references of compliance with ABNT [NBR ISO/IEC 17025](#);
- reference to the calibration system and database;
- calibration certificates of the manufacturer;
- other applicable tests;
- values obtained in measurements;
- corrected values of the measurements;
- calculation of the systematic errors;
- calculation of calibration uncertainty;
- laboratory temperature and humidity during calibration.

6.1.1.4 The uncertainty calculation shall consider at least the uncertainties of the standards used and the random errors obtained in the calibration. When there are requirements which are more strict to this uncertainty calculation, other contributions shall be included. The calculation form shall be in accordance with Annex A of PETROBRAS [N-1882](#) and shall be submitted to inspection for approval.

6.1.1.5 Annex A of PETROBRAS [N-1882](#) shall be considered as reference for calculation of measurement uncertainties.

6.1.1.6 The procedures shall include the specific requirements provided in this Standard for every type of material, instrument, equipment or automation system.

6.1.2 Plan of Issuance and Approval of the Documents

6.1.2.1 A plan of issuance and approval for the calibration phase shall be prepared so as to cover all calibration activities, standards and material to be used. The documents shall be approved and reviewed by the Technician in Charge and shall contain observation points both for the contractor and for inspection.

6.1.2.2 The instruments shall undergo a new calibration or calibration check, even when the factory tests have been monitored by the purchaser.

6.2 General Technical Requirements

6.2.1 Initial Conditions

6.2.1.1 Upon receipt for calibration, the following items and documents shall be observed:

- a) visual check of the original package in order to check for maintenance of the condition in which it left the factory, transportation and storage;
- b) visual inspection to check for corrosion and damage from storage and transportation to the place of calibration;
- c) checking of the compliance supporting documents regarding the design, invalid or obsolete documents shall be removed;
- d) checking of the compliance supporting documents regarding the design with the revisions which shall be stored;
- e) checking of the basic documentation associated to the product such as drawings, manuals, warranty certificates, usage instructions, etc;
- f) specific checks for each type of calibration equipment or material;
- g) checking of accessories and spare parts such as: supports, assembly connectors, extenders, configurators, etc;
- h) manufacturer's documents, software and calibration certificates, checking at least the following items:
 - instrument identification;
 - measurement error in % (bottom of scale or of reading);
 - hysteresis;
 - dead band;
 - linearity.

6.2.1.2 Procedures such as network communication, may be executed later, during the assembly, conditioning or commissioning phase, in case there is not the minimum structure needed to perform them in laboratory.

6.2.1.3 All calibration activities shall be performed based on design documents with certificated status. In case it is not possible to comply with this recommendation, this deviation shall be addressed with PETROBRAS. The revision of the design document used during the procedure shall be recorded.

6.2.1.4 The control system of consumables for calibration of instrumentation equipment shall keep the records materials and products specifications, and the applications performed.

6.2.1.5 The equipment and software defined in the method and used in the calibration shall be capable of maintaining the accuracy, and shall be checked prior to being used.

6.2.1.6 The unusable calibration equipment shall be taken out of service and be segregated so as not to be accidentally used.

6.2.1.7 Instrumentation equipment, including instruments impossible to be calibrated in the receipt location (work, site or facility) such as measuring turbines, positive displacement meters and mass flow meters shall be sent with performance test certificates which comply with the needs for metrological traceability, uncertainties, deviations and other design requirements.

6.2.1.8 For equipment which only traceability with INMETRO is required by the Quality contract Annex, the manufacturer may choose for calibration and issuance of a certificate using their own standard, traceable to the Brazilian Calibration Network. In this case, it must be sent with a copy of the calibration certificate of the standards used.

6.2.1.9 Calibration of the valve shall consider the usage resources of digital positioners with Hart or available field networks. The same procedure shall be considered for valves in safety instrumented systems.

6.2.1.10 Calibration of instruments used in Fiscal Metering Stations and Custody Transfer Stations (EMED) shall be calibrated by the Brazilian Calibration Network (RBC), as required by the ANP regulations.

6.2.2 Scope of Calibration

6.2.2.1 Calibration of instrumentation assembled to static or mechanical equipment, whether this equipment belongs to a skid or not, shall be individual and in detail for the instrumentation items or material.

6.2.2.2 Calibration on inputs and outputs of automation systems shall be checked during the factory acceptance test. In an on-field acceptance test and in grid tests, considering that the instrumentation is already connected to the equipment, the analysis shall consider the set's Probable Total Error (PTE), when applicable.

6.2.2.3 Zero compensation for reading of variables shall be included in the calibration procedure such as intake position (zero suppression and elevation), sealing, position and assembly details and material compatibility for when this interferes with the measurement, for example, in extension wires during temperature measurement.

6.2.2.4 A warning shall be included in the calibration procedure when readings in absolute pressure are required.

6.2.2.5 Atmospheric pressure compensation adjustments shall be included in the calibration when compensation is required.

6.2.2.6 For electronic instruments, screen parameters settings defined by the project such as engineering unit, the working range and the number of significant digits that shall be observed in the instrument display shall be included in the calibration.

6.2.2.7 For smart instruments connected to on-field networks, the adopted procedure and the calibration documents shall consider the resources that the instrument manufacturer's model is able to offer.

6.2.2.8 Analysis of calibration of smart instruments shall additionally include design checking regarding functional blocks, transducer and sensor blocks, and their respective configuration files.

6.2.3 Environmental Conditions

6.2.3.1 The environmental conditions shall not change the calibration result to the extent of affecting the on-field performance of the instrumentation equipment. In the absence of more restrictive limits to the temperature and relative humidity in the lab, these shall be kept within the values shown below:

- a) general instruments: $(24 \pm 2) ^\circ\text{C}$;
- b) dimensional: $(21 \pm 2) ^\circ\text{C}$;
- c) relative humidity: $(50 \pm 10) \%$.

6.2.3.2 Standards shall be at least three times more accurate, shall have a tag indicating the expiration date of its calibration and shall be in perfect usage conditions.

6.2.3.3 Machinery, equipment and tools which are required for the task shall be available and in perfect working conditions.

6.2.3.4 Standard instruments storage shall be appropriate to the instrument type.

6.2.4 Calibration Method

6.2.4.1 Calibration methods for instrumentation equipment shall be documented, as well as the statistical techniques for results, data sampling and assembly elements controlling.

6.2.4.2 Equipment used for any activity in calibration, testing and others shall have a defined method for its own calibration in accordance with manufacturing standards such as ABNT NBR 14105-1 for pressure gauges, ABNT NBR 13881 for thermometers or by manufacturer. If this is not possible, an alternative method shall be submitted to PETROBRAS to be validated.

6.2.4.3 For calibration methods not addressed in the standards mentioned in 6.2.4.2, there must be a step of validation of results by comparing them with the use of other reference standards, other calibration methods including assessment of the uncertainty of the methods used.

6.2.4.4 The computers for the software and the calibration data should be protected against data loss.

6.2.5 Metrology

6.2.5.1 At the measurement location, all abnormalities found during calibration shall be recorded, including those which contribute to increase its uncertainty.

6.2.5.2 There shall be an immediate action so as to correct the incorrect measurements or the significant errors which may be corrected prior to the issuance of the calibration report.

6.2.5.3 Calibration involves, in every situation, at least a measuring instrument.

6.2.5.4 If two measuring instruments are necessary, such as in the calibration of a pressure transmitter, the variable shall be applied to the instrument with the largest uncertainty, usually the pressure gauge, matching readings that match the marks or indications or full values such as 5.0 kPa, 6.5 Bar. The reading should be performed in the instrument with the lowest uncertainty, usually the milliamperemeter, which has a greater number of significant digits, minimizing errors.

6.3 Specific Technical Requirements

6.3.1 Transmitting Instruments

6.3.1.1 For transmitters calibration, compliance check of indicated and transmitted values shall be included, regarding standards for each type of transmitter.

6.3.1.2 During calibration, check the operation settings, output signal and local indication as well as the setting parameters of smart transmitters with calibrators or calibration systems.

6.3.1.3 During calibration, check for possible assembly details involving possible inadequacies of calibration after assembly. (E.g.: Zero suppressions and elevations).

6.3.1.4 For calibration of transmitters on field networks, the parameters of transducers and sensor blocks may be measured and checked through the asset management system or with the use of calibrators or calibration systems.

[Recommended Practice]

6.3.1.5 For calibration of instruments that shall operate with fluids whose density differs from 1 or which have and measure the interface, and this influences the expected result, the values shall be corrected for the specified density.

6.3.2 Measuring Systems

For calibration of systems, the main design aspects shall be checked, as well as their relevant functional characteristics such as the values of voltage, current, signal inputs and outputs, drive time and working pressure. This applies when the system is directly connected to the instrumentation as an analyzer or an EMED. It also applies when an equipment such as a generator, a compressor or a pump have assembled instruments.

6.3.3 Rearrangement, Command and Control Panels, Insulators, Auxiliary Systems

6.3.3.1 Calibration shall include checking of compliance to the design, regarding inputs, outputs and compliance with the signals.

6.3.3.2 Calibration shall be prepared having as reference the manufacturer of each piece of equipment, which shall be customized for the intended application.

6.3.3.3 Auxiliary systems (analytical systems, displacement and vibration monitors, gas and fire detection, among others) shall be checked with setting tools and software provided by the manufacturer.

6.3.3.4 Each component of automation systems shall have a calibration report or a specific setting.

6.3.4 Sensors and Analyzers

6.3.4.1 For temperature instruments, the documents regarding the “electrical signal versus temperature” conversion table shall be included and checked.

6.3.4.2 Vibration sensors shall be checked along with the manufacturer’s systems.

6.3.4.3 In case there are radioactive-type level meters, requirements of CNEN [NN-3.01](#), [NE-3.02](#) and [NE-5.01](#) shall be included, as well as the radioprotection plan and specific procedures of the Operating Unit.

6.3.4.4 Analytical instruments shall be always calibrated and validated in accordance with the standard sample basis (characteristics, certificate of analysis and expiration date).

6.3.4.5 When applying standard sample cylinders, compliance and traceability of the cylinders as to the composition of the sample and its expiration date check shall be included.

6.3.4.6 For the field network sensors, the network performance should be checked.

6.3.5 Motorized, Pneumatic, Hydraulic and Control Valves

6.3.5.1 Control valve calibration shall be checked as to its performance in accordance with the Data Sheet.

6.3.5.2 The positioners shall be checked along with the valve and I/P converter.

6.3.5.3 For smart positioners, calibration shall be prepared having as reference the manufacturer's recommendations, using the auto-calibration function and the checking of the customized parameters for the intended application, whenever this applies.

6.3.5.4 There shall also be the check of other devices used as accessories such as solenoid valves, torque wrenches, pilots and local/remote drive.

6.3.5.5 The position indicators of the valves shall be checked in relation to its operating and correct position of insertion by the signal simulator.

6.3.5.6 The sealing category shall be checked.

6.3.6 Safety Valves

The safety valves and relief devices shall comply with PETROBRAS [N-2368](#).

6.3.7 Rotameters

6.3.7.1 In rotameters, zero flow condition and the calibration certificate shall be checked.

6.3.7.2 In rotameters, checking of meter type, scale and floater type shall also be included.

6.4 Records

6.4.1 In the case of configurable instruments or systems, the calibration certificates shall contain the value of all set parameters during calibration.

6.4.2 The calibration certificate of level instrument shall record the minimum (0%) and maximum (100 %) level quotas relative to the bottom tangency line in vertical or horizontal vessels when the instrument is installed directly to the vessel; or relative to the intakes to the vessel.

6.4.3 During calibration, the versions of all software and firmware used shall be checked and recorded.

6.4.4 The form of temporary storage of calibration certificates in magnetic or physical media or both, as well as the processing throughout the calibration process depends on PETROBRAS approval.

6.4.5 The calibration certificate or report, after final processing, shall be filed along the received compliance documents and generated during conditioning by the Activities Management System.

7 Assembly

7.1 Documentation Requirements

7.1.1 For construction and assembly of instruments, automation systems, associated instruments and analysis, the design guidelines, supplier's procedures and recommendations, manufacturers, standards and recommended practices in the petrochemical, transportation, power and oil & gas industries shall be adhered to in accordance with what is described in this Standard.

7.1.2 The assembler shall not change the manufacturers' recommendations, design and procedures without prior authorization from PETROBRAS.

7.1.3 During assembly, it is essential that the design documents being considered are in their latest revision.

7.2 Execution Planning Requirements

7.2.1 The assembler shall issue, for PETROBRAS approval, a plan with the entire assembly sequence, detailing its activities, schedule and precedence network, considering the SOPs and sub-SOPs for the execution of the assembly relative to the systems of automation, analysis and instruments, as well as all auxiliary services needed to their completion.

7.2.2 All these forms regarding assembly, tests and conditioning shall include the entire scope of the completion of the unit under construction.

7.3 General Technical Requirements

7.3.1 The quality of assembly, testing and conditioning services mentioned in this Standard shall be ensured by the proper execution of these services, according to recommendations made through procedures executed by the assembler itself or provided by the manufacturers of the equipment or system.

7.3.2 The assembler shall ensure and PETROBRAS shall heed so that the technical services performed under the assembler's responsibility comply with the standardized requirements and needs of:

- superficial finishing and painting;
- removal of all burrs and sharp edges on every material subject to cuts during the assembly phase;
- visual access and access for maintenance of all instruments, junction boxes, panels and other elements which require constant access for maintenance and operation;
- ensure parallelism and alignment free of stress and/or efforts in flanges and connections which may damage the instrument or system over its lifetime;
- ensure the slope in facilities with tubing for impulse lines;
- appropriate fixation to signal and impulse lines;
- manufacture and implementation of supports for instruments, boxes and panels;
- tying and fixation of cables and harnesses;
- intentional grounding of instruments, boxes, panels and components of the automation and instrumentation systems;
- installation of conduit routing to allow drainage of condensate for the entire conduit;
- proper connection of drains and low points of the impulse intakes for collectors;
- execution of filling and sealing of impulse intake.

7.3.3 Solutions of intentional continuity at the thermal expansion joints in long lengths of conduit shall be flexible so as not to compromise full operation of the joint.

7.3.4 The use of different metal connectors and terminals shall be avoided in connections between parts to prevent formation of a galvanic cell.

7.3.5 When assembling electrical connectors in structures and similar installations, existing coating and paint shall be removed from the metal parts, ensuring full metal contact. In this location, the painting shall be restored in places not covered by the contact, after installation of the connectors.

7.3.6 The various types of instruments, equipment and systems of automation and/or analysis shall comply with specific instructions for installation, in accordance with typical assembly details.

7.4 Specific Technical Requirements

7.4.1 Conduits, Raceways and Trays

7.4.1.1 The routing of conduits, raceways and trays shall be approved by PETROBRAS. The routing shall be as straight as possible between source and destination, considering accessibility for future expansions; exposure to high temperatures, electromagnetic interference, risk of shock with mobile equipment, leaks of process products and steam shall be avoided.

7.4.1.2 When assembling conduits, raceways, trays and accessories, in case mechanical operations such as cutting, machining and threading are needed, the affected areas shall be treated with products to restore its original covering condition and its plate protection, i.e., an anti-corrosive coating shall be applied.

7.4.1.3 Threading may be performed with a manual or electric die-nut. After threading, the integrity of the threads of the screw shall be checked.

7.4.1.4 For the anti-corrosive protection, clean the threads of the screw with solvents, and later, apply the first coating of anti-corrosive paint. When assembling the conduit, tighten it correctly and, in the exposed areas of the connections, apply a second coating of anti-corrosive paint. Note the restriction provided in 7.4.1.9.

7.4.1.5 Assembly of conduits, including the flexible, shall be performed through a lower or side access to the instruments and boxes.

7.4.1.6 The intervals for fixing the conduits to the brackets shall be, at most, 2 m for conduits with a diameter smaller than 3/4", and at most 3 m for conduits with a diameter equal to or higher than 3/4".

7.4.1.7 For assembly of conduits in a classified area, according to ABNT [NBR IEC 60079-14](#), the stretch which must be extra-heavy and seamless, with accessories which are suitable to the area classification is the one between the sealing unit and the instrument itself. In this case, the distance may not be higher than 45 cm. Other stretches, including their accessories, are specified only as mechanical protection, and do not need to comply with requirements of the area classification standard.

7.4.1.8 In the passage of a conduit from a classified zone to another zone with a different classification, a sealing unit shall be assembled. In this case, there may be no other accessory between the unit and the border between zones.

7.4.1.9 When assembling conduits also used as protective grounding conductors, the intentional electrical continuity shall be ensured. In this case, the product to be used on the hidden threads is the graphite grease, which protects and facilitates the transmission of electrical current; those which are apparent shall be fitted with anti-corrosive protection.

7.4.1.10 For long stretches of conduit, a system performing satisfactory drainage of possible water condensations shall be installed.

7.4.1.11 For assembly of tray cable supporting and routing system, PETROBRAS N-1997 shall be used.

7.4.2 Cables and Multicables

7.4.2.1 Routing of cables through conduits, raceways and trays shall comply with the capacity of conductors for each conduit diameter and/or dimension of trays and raceways, as specified in the design.

7.4.2.2 When this is not defined on the design, individual and collective shielding shall be continuous up to the control room, being grounded only at this point.

7.4.2.3 Cables and conductors which compose electrical supply systems shall be physically arranged so as to minimize the physical space between conductors. In case single conductors are used, it is necessary to assemble a physical structure for the cables and the proper securing of the arrangement through the use of plastic cable ties.

7.4.2.4 Where the power supply of equipment and instruments is separated from the signal, the routing of power cables shall coincide with the routing of the signal cable, but in different infrastructures (raceways or trays).

7.4.2.5 Signal cables shall be segregated according to the signal level and its function.

7.4.2.6 For the assembly of frequency converters, comply with the specific manufacturer's recommendations. In case there are none, the smallest possible length of cable at the connection between the frequency converter and the load shall be implemented. Use shielded conductors. Shielding shall be connected to the ground potential at converter and load ends.

7.4.2.7 Enclose conductors which connect converters and loads within a metal infrastructure, preferably inside metal conduit **[Recommended Practice]**

7.4.2.8 When assembling cables, the correct installation of wire rope grips, sealing units and cable bends shall be checked so as to prevent water from entering.

7.4.3 Tubing

7.4.3.1 Impulse lines shall be routed in parallel and aligned so that the impulse line length shall be as small as possible, preventing it from exceeding 10 meters.

7.4.3.2 The use of threaded connections is limited. See PETROBRAS [N-2791](#) for the installation details.

7.4.3.3 For assembly of washers in tubing, check with manufacturer about which measures and controls shall be adopted for the assembly and tightening. No sealing shall be placed on threads of flanges or on compression washers.

7.4.3.4 When assembling compression fitting, the assembler must heed the correct assembly of the position, elements of the same manufacturer and type of washer.

7.4.3.5 The definite tightening of threaded or compression fittings shall only be performed as of the execution of mechanical strength tests (hydrostatic/pneumatic).

7.4.3.6 For flanged joints, a gasket which is proper to the operating pressure and temperature conditions shall be used according to PETROBRAS [N-76](#) and [N-1931](#).

7.4.3.7 Impulse line supports shall not be welded to process piping.

7.4.3.8 When brackets are supported on piping, clamp type supports is recommended. **[Recommended Practice]**

7.4.3.9 When using clamp-type supports and the piping operates with fluids with temperatures over 200 °C, the clamp shall be filled internally with thermal insulation.

7.4.3.10 Apply thermal insulation between the bracket and the piping when the temperature of the fluid in the piping exceeds 200 °C.

7.4.3.11 Carbon steel impulse lines shall be assembled coated with anti-corrosive paint, also in the welded stretch.

7.4.3.12 The required supports shall be completed prior to the assembly of impulse lines. They are understood as being completed after blasting, welding, bolting and painting with at least an anti-corrosive paint, also for required holes and threads.

7.4.3.13 Check the position of the impulse intakes relative to the process fluid, according to the typical detail of installation to the process. Pockets of gas in liquids and in liquids columns in wet gas shall not be created. Slope requirements prescribed in PETROBRAS [N-1882](#) for horizontal sections shall be applied. Observe the design detailing specifications, in accordance with PETROBRAS [N-2791](#).

7.4.3.14 Impulse lines shall be secured to supports so as to avoid the galvanic corrosion which can occur when they get into contact with dissimilar materials as it is the case with stainless steel tubing and the carbon steel support. Apply resources for insulation of contact for electrical current.

7.4.3.15 Signal lines, impulse lines and power lines using tubing shall be physically protected throughout its entire routing, using the main power line itself (header), channels or angle brackets. Tubing shall be fixed to protective devices at every 3 m but shall not be directly fixed to piping or equipment.

7.4.4 Instruments and Junction Boxes

7.4.4.1 Instruments and terminal boxes may only be assembled after the bracket is positioned, fixed and painted.

7.4.4.2 The connection terminal system shall comply with the box specification for the classified area in which it will be assembled. Terminals manufactured with thermoplastic material are not acceptable, even if the box is intended for an unclassified area.

7.4.4.3 When placing instruments, check for interferences with escape routes, need of viewing local indicators, access for disassembly and maintenance.

7.4.4.4 It is recommended that the height of assembly of instruments and junction boxes is between 1,45 m and 1,55 m above the floor the operator is on to record the reading. **[Recommended Practice]**

7.4.4.5 According to ABNT [NBR IEC 60079-14](#), in order to add entries through holes on junction boxes, they shall comply with the regulatory certification requirements as to the classified area. These holes may only be opened by the manufacturer of the box and be provided in the certification of the manufacturer of the box, also as to the position of the hole.

7.4.4.6 According to API [RP 520 Part II](#), relief and safety valves shall be assembled vertically.

7.4.4.7 According to PETROBRAS [N-1882](#), the assembly of relief and safety valves to the outlet piping shall drain liquids which get built-up in the outlet, but not by laying it in its seating.

7.5 Records

Every task detailed in the assembly and construction planning, and by the Activities Management System shall be recorded as performed in specific forms, produced by the assembler, and monitored by PETROBRAS, which, at the completion of each activity, shall approve it or not.

8 Conditioning

Its purpose is to evaluate, assess and certify the physical compliance of equipment, instruments and interconnections in order to approve the systems to the next stage, regarding the technical design specifications and the requirements of Quality, Health, Safety and Environment (QHSE).

They are characterized by checks, necessary measures, adjustments, simulation and certification tests, performed energized or unenergized without load and/or pressurized without definite operation fluid, after completion of the construction and assembly phase. It typically encompasses activities of conservation, calibration, grid certification testing, inspection and compliance with [NR-10](#) and [NR-13](#), aiming to ensure that the equipment, individually, is able to operate satisfactorily. Some activities have already been detailed in this Standard as Calibration and Receipt Inspection, as well as other activities to be performed inserted in this Chapter are additional to the text of IEC [62337](#), [62381](#) and [62382](#).

8.1 Documentation Requirements

8.1.1 A procedure for each of the tests required in the Activities Management System shall be prepared by the assembler. This procedure shall determine, where applicable, what shall be checked regarding:

- a) documents generated by previous tests and trials;
- b) documents generated in the work such as reports, Non-Compliance Reports (NCRs), etc;
- c) visual inspection of components and assembly;
- d) field tests such as those mentioned below to:
 - test on hydraulic and pneumatic lines;
 - test on electrical and digital lines;
 - industrial networks tests;
 - simulations (field acceptance test);
 - loop test.

8.1.2 The procedure shall require that the tests are performed only after completion of assembly of all elements which integrate the test, and when it is no longer needed, disassemble the equipment, the instrument and the signal line so as to validate the test or trial.

8.1.3 The conditioning procedures involving voltage above 50 Vac or 120 Vdc shall be signed by an authorized professional, complying with the recommendation of [NR-10](#) of the Ministry of Labor and Employment.

8.1.4 For temperature instruments, the procedure shall provide checking of ambient temperature compensation, according to the design recommendations, in the simulation of indicator instruments and/or temperature recorders using thermocouples. A check of the cabling polarity shall also be included in this procedure.

8.1.5 The procedure shall require checking of the flow direction for the primary flow elements, its accessories and straight sections of piping involved in each leg, in accordance with the design documents.

8.1.6 For control valves, the procedure shall require:

- checking of flow direction relative to the process fluid;
- checking of free space on the installation of the valves. to the free space shall allow removal of actuator, internal parts and bottom of the valves, without removing the body from the piping;
- checking of assembly as to the compatibility between piping fittings and piping classes;
- checking of installation as to the proper viewing of the valve opening indicator, as well as easy viewing and access to the positioner;
- final adjustment, in the operating conditions, for all control valves;
- fine setpoint tuning for the self-operated valves, which shall be done during operation in actual process conditions.

8.1.7 For analyzers and detectors, the procedure shall require validation, using standard samples, depending on the type and the manufacturer's recommendations.

8.1.8 Some required tests, such as network communication, may be performed later, in the commissioning phase, in case there is not the minimum structure required for them to be performed in the laboratory. This situation shall be individually addressed, during the planning of activities, with PETROBRAS.

8.1.9 The procedures shall include the specific requirements provided in this Standard for each type of material, instrument, equipment or automation system.

8.2 General Technical Requirements for Tests and Trials

8.2.1 For verification prior to the execution of structural strength tests applicable to hydraulic and pneumatic lines (impulse, power and signal) and in instrumentation equipment, the procedure shall include parameters for:

- checking of compliance documentation;
- visual examination of the assembly (backing, alignment, slope, discontinuity of liquid or gas column);
- mechanical strength test of the assembly for impulse lines (hydrostatic and pneumatic);
- mechanical strength test of the assembly for signal and power hydrostatic or pneumatic, depending on the type of supply).

8.2.2 The procedure shall require that, after the hydrostatic testing of the lines where the instruments/components are assembled, the impulse lines with compression fittings shall be pneumatically tested with a pressure identical to that of the unit's instrument air system's test pressure, when applicable.

8.2.3 The electrical tests procedure applicable to (electric or digital) signal and power lines. The procedure shall include parameters for:

- checking of compliance documents;
- visual examination of the assembly (backing, alignment, securing, identification, separation of signals);
- certification of assembly.

8.2.4 The electric insulation test procedure shall provide checking of grounding for all instruments or equipment and of the signal cabling involved in the grid.

8.2.5 The loop test documents shall be prepared in compliance with the design documents and with this Standard, and shall include the provided general minimum content and the following additional information, where necessary:

- specifications of the instruments;
- tables with the checking and tests provided in the loop test;
- instructions for opening of monitoring reports in the recording and management systems such as SAP R3, ICT or MSC;
- visual and mechanical checking;
- provided metrological checking (signal injection and readings);
- location to record measured values;
- reference to the procedure and other documents in paper or electronic media;

- reference to the standards used and traced by the Brazilian calibration network;
- reference to the grid test management system and database;
- conditions and abnormalities;
- acceptance report.

8.2.6 The loop test procedure shall provide the checking of the design data through the manual programmer in the asset management system or instruments and in equipment that have already been pre-programmed. This checking shall not replace the individual checking of the loop's instrument/component.

8.2.7 The loop test procedure shall require the execution of the test with the injection of the process variable. For analog systems, it shall be 0 %, 25 %, 50 %, 75 % and 100 % of the value obtained in the Data Sheet. Alternatives to the tests shall be approved by PETROBRAS.

8.2.8 The procedure for checking and testing of cables for communications networks shall include parameters for:

- checking of compliance documents;
- visual examination of the assembly (backing, alignment, securing, identification, separation of signals);
- certification of assembly.

8.3 Specific Technical Requirements for Tests and Trials

8.3.1 Pneumatic and Hydrostatic Testing

8.3.1.1 Applicable to every instrument or material which is subject to pressure during operation, e.g. chambers of differential transmitters instruments, indicators, temperature wells and impulse lines.

8.3.1.2 Where there is no standard or specification referencing specifications for mechanical strength testing, the following parameters described in 8.3.1.3 to 8.3.1.18 shall be complied with:

8.3.1.3 The test fluid shall be non-aggressive, impurity-free water, at a temperature equal to or higher than 15 °C. For testing in stainless steel lines, the water shall be free of chlorine.

8.3.1.4 For the values for mechanical strength testing, the test pressure shall be one and a half times the design pressure.

8.3.1.5 If the operating pressure of the equipment is up to 1,034 kPa (150 psi) and the pressure class of the instrument allows it, the minimum test pressure shall be 1,551 kPa (225 psi).

8.3.1.6 The maximum test pressure shall be kept for, at least, 30 minutes for testing purposes.

8.3.1.7 The pressure elevation rate shall be 490 kPa/min.

8.3.1.8 If hydrostatic test is required, eliminate air pockets which may eventually have been formed in the filling. If pneumatic test is required, eliminate possible liquid which may be present.

8.3.1.9 Use two calibrated pressure gauges to read the pressure. These pressure gauges shall have resolution, range and uncertainty consistent with the test needing to be performed.

8.3.1.10 The system provided for the test shall be capable of generating and keeping the pressure, safely after reaching the expected pressure, without leaks which could be attributed to possible pressure drops that may mask the results.

8.3.1.11 Before applying pressure, the instrument shall be completely dry on the outside, with no apparent humidity, which may invalidate or mask the results.

8.3.1.12 After the expected pressure is reached, completely block the source of pressure and, keep it stable during the required time. Because of safety issues, before proceeding with visual inspections, drop the pressure to 90 % of the required value for the test.

8.3.1.13 During the visual inspection, observe the possible leaks through joints, connections, welds or the body.

8.3.1.14 Contact with the system shall be carried on only after the set is fully de-energized.

8.3.1.15 In case of small leaks, if simple tightening was foreseen, de-energize the system and proceed to tighten it up to the maximum torque specified by the manufacturer or standard, repeating the test. In case there are more than two sets, also refer to the required sequence and form of tightening.

8.3.1.16 These tests apply to all chambers of instruments which are, somehow, subject to pressure. The tests shall be performed on the same side that it is subject to pressure when in operation, for example, wells shall be tested from the outside-in.

8.3.1.17 Instruments with buoys or floaters shall have them removed, identified and stored during the hydrostatic test of the equipment.

8.3.1.18 Instruments with buoys or floaters shall have their chamber filled with water for a minimum time of 5 hours, aiming to check for problems with liquid penetrating in the buoys or floaters. The test time may be reduced by pressurizing the chamber of the instrument with a pressure identical to the operating pressure.

8.3.2 Tightness Test in Connections

8.3.2.1 This test applies to the pneumatic supply lines. It includes the main supplier (header) and the branches (sub-headers), signal lines, impulse lines and pneumatic supply lines.

8.3.2.2 Where there is no standard or specification referencing the values for tests, the following parameters shall be adhered to:

- for tightness of connections, the test pressure shall be the operating pressure of the main header;



— the minimum application time shall be 24 hours for the main header and 30 minutes for the branches. The time shall be recorded after the maximum test pressure is reached and kept.

8.3.2.3 Use two calibrated pressure gauges to read the pressure. These pressure gauges shall have resolution, range and uncertainty consistent with the test needing to be performed.

8.3.2.4 The system provided for the test shall be capable of generating and keeping the expected pressure, without leaks which may mask the results.

8.3.2.5 Before applying pressure, the system to be tested shall be cleaned on the outside so as not to invalidate or mask the result.

8.3.2.6 Once the expected pressure is reached, completely block the pressure source and keep it stable during the expected time. Spray soapy water for foaming for easier viewing in case of small leaks. Perform a visual inspection, noting possible leaks through joints, connections, welds and the body.

8.3.2.7 In case of small leaks, if simple tightening was foreseen, proceed to tighten it up to the maximum torque specified, repeating the test. In case there are more than two sets, also refer to the required sequence and form of tightening.

8.3.2.8 Both flanges may be involved with an adhesive tape, running along the gap in the gasket, and then, drilling a hole in a position to facilitate viewing, spray the foam on the hole that concentrates the air outlet in case of leaks.

8.3.3 Insulation Strength Test

8.3.3.1 The insulation strength test applies to every instrument or material which shall be subject to signals or power supply during the operation such as: field instruments, panels and wires.

8.3.3.2 Where there is no specific standard or specification referencing values for the insulation strength test, it shall be placed at around 20 Mohms, measured with a specific meter for insulation strength.

8.3.3.3 For cables and multicables, every conductor shall be tested against the other and each one against the grounding wire.

8.3.3.4 The minimum application time shall be 1 minute after the test voltage is reached and kept. After this time, the stability of the system shall be checked and the value may be read.

8.3.3.5 The system provided for the test shall be capable of generating and keeping the voltage, safely and without leaks which could be attributed to possible voltage drops that may mask the results.

8.3.3.6 Contact with the system shall be carried on only after the set is fully de-energized.

8.3.3.7 During visual inspection, check for possible leaks which are verified by fluctuations in the reading system.

8.3.4 Continuity Test on Contacts & Cables

8.3.4.1 The continuity test on contacts and cables applies to every instrument or material containing electrical on/off switches such as: cables and level/pressure switches-type on-field instruments.

NOTE The use of level/pressure switches is limited.

8.3.4.2 Where there is no specific standard or specification referencing values for the contact strength and continuity test, it shall be placed at around 0 ohms, measured with an ohmmeter in its smaller scale after elapsing of 1 minute from the application of the voltage.

8.3.4.3 For cables and multicables, every conductor should be tested.

8.3.4.4 The system provided for the test shall be capable of generating and keeping the voltage, safely and without leaks which could be attributed to possible voltage drops that may mask the results.

8.3.4.5 During visual inspection, check for possible fluctuations in the reading system.

8.3.4.6 Both contacts shall be measured, but for contacts which are open under normal circumstances, its closure shall be simulated through signal injection of the corresponding variable such as pressure, level and temperature.

8.3.5 Loop Test

8.3.5.1 When, during the loop test, the following items and documents shall be observed:

- checking of the prepared documents such as receipt records, tests, calibration, etc. The checking shall evaluate compliance of the documents which were generated up to the moment of this checking. For the trials and tests with invalid records, the test shall be repeated and recorded;
- visual check, more commonly known as mechanical checking of assembly and executed with the purpose of checking compliance with the typical assembly details, wiring diagrams, floor plans, data sheets and other design documents;
- checking through quality tests and measurements regarding assembly, such as correct tightening of washers (test with pressure), maintenance of the insulation capacity and running of cables and multicables (using the continuity and insulation electrical tests);
- injection of the process variables and reading on the panel and on the final element. Record the completed checking, file a report and feed the pending items management system.

8.3.5.2 Some components of the loop may be part of more than one loop (such as a multicable or a junction box). For these components, the test or the check required for each type of equipment may be restricted to the pair, in the case of a multicable, or to the equipment as a whole, as may be a junction box. In both cases, they shall be associated in all loops. The check, however, may be performed only once.

8.3.5.3 Every loop test activity is recommended to be performed based on the design documents with the “certified” status. The revision used during the procedure shall be recorded. **[Recommended Practice]**

8.3.5.4 The control system of consumables for the loop test under any use (gas, chemicals, etc.) shall allow control and checking for the specification required to the activity to be performed.

8.3.5.5 Activities such as receipt inspection, calibration, electrical testing in cables and structural strength testing, which precede the loop test shall have already been performed with satisfactory results, as required in the Activities Management System.

8.3.5.6 An alternative to the test shall be provided in the procedure for situations where it is impossible to execute the injection of process variables such as the use of a resistive decade to simulate temperature in a thermal resistance. For these cases, additional checks and measurements shall be performed with the sensor.

8.3.5.7 Screen-setting data checks shall cover information that the instrument may provide locally, as well as the data it transfers via cable to the system.

8.3.6 Tests on Optical Fibers

In optical fiber cabling tests, the optical attenuation of the cable and the connections shall be checked. This test is performed with the optical reflectometer in the time domain or in another similar device which provides data for checking the transmission quality of the optical fiber. The optical connections shall also be tested, as well as other connections, and the required testing is that of optical attenuation.

NOTE Note the non-compliance of welding of single-mode fibers in multi-mode fibers.

8.4 Records

8.4.1 Every task detailed in the assembly and construction planning and by the Activities Management System provided in conditioning shall have its implementation recorded in specific forms, produced by the assembler and monitored by PETROBRAS inspection, which, at the end of each activity, shall approve it or not.

8.4.2 After the tests and trials, the instrument shall be tagged as to the completion of the respective conditioning phase. The tag shall never be unreadable, even due to environmental conditions, during its validity period. The tag shall have at least the registration tag of the instrument, the date of execution of the activity, the readable name and the signature of the one who is performing the activity. Automated or electronic means such as Radio Frequency Identification (RFID) or barcode may be used, associated to their respective readers.

INDEX OF REVISIONS	
REV. A and B	
There is no index of revisions.	
REV. C	
Affected Parts	Description of Alteration
1.1 and 1.2	Revised e Renumbered
1.3 and 1.4	Included
2	Revised
3	Revised
3.7	Eliminated
3.35 and 3.36	Included
4.1 and 4.2	Revised
4.2.1.7	Included
4.2.3.4	Eliminated
4.2.8.18	Included
4.3 and 4.6	Revised
5.1 and 5.5	Revised
TABLES 2, 4 and 5	Revised
5.6	Revised
5.6.1.9	Included
TABLES 6 and 7	Revised
5.7 and 5.8	Revised
TABLE 8	Eliminated
TABLES 9 at 11	Revised e Renumbered
5.10 at 5.13	Revised
TABLE 13	Eliminated
5.14 and 5.15	Revised
ANNEX A	Revised
REV. D	
Affected Parts	Description of Alteration
All	Revised