

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.

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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.

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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 Magnetic 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.