

CONTEC

Comissão de Normalização
Técnica

SC-15

Cathodic Protection

Rectifiers for Cathodic Protection

Revalidation

Revalidated em 01/2017.

Rectifiers for Cathodic Protection

Specification

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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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.

Foreword

This Standard is the English version (issued in 06/2012) of PETROBRAS N-2608 REV. B 12/2011. 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 minimum requirements for the design, manufacturing and testing of rectifiers used in cathodic protection systems on PETROBRAS' on-shore and off-shore facilities.

1.2 This Standard is applicable to designs started as of its date of issuance.

1.3 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.

Norma Regulamentadora [NR-10](#) - Segurança em Instalações e Serviços em Eletricidade;

PETROBRAS [N-1021](#) - Pintura de Superfícies Galvanizadas, Ligas Ferrosas e não Ferrosas, Materiais Compósitos e Poliméricos;

PETROBRAS [N-1735](#) - Painting of Electrical Equipment, Machines and Instruments;

PETROBRAS [N-1219](#) - Colors;

ABNT [NBR 5410](#) - Instalações Elétricas de Baixa Tensão;

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

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 General Conditions

3.1 Data Sheet

3.1.1 The specific characteristics of each rectifier are those indicated on their respective Data Sheets.

3.1.2 In cases of discrepancies between the Data Sheet of Annex A and this Standard, the information contained in the former shall prevail.

3.1.3 The supplier shall complete all blank items on the Data Sheet of Annex A (technical data, list of standards used in the design, manufacturing and testing, as well as the list of tests).

3.2 The rectifier shall have a bridge type full wave rectification system for full load operation in continuous duty.

3.3 The rectifier for on-shore facilities shall be in accordance with [NR-10](#).

3.4 The rectifier for off-shore facilities shall meet the recommendations of the Classification Societies.

4 Environmental Conditions

4.1 It is recommended that the rectifier operates from weather protected locations and in an unclassified area. **[Recommended Practice]**

4.2 The ambient temperature range is 0 °C to 50 °C or as defined on the Data Sheet of Annex A.

4.3 Maximum uncondensed air relative humidity is 95%.

5 Constructive Characteristics

5.1 Rectifier shall be manufactured so as to facilitate maintenance and minimize repair time and allow easy access to internal components.

5.2 Rectifier shall be resistant to corrosion caused by the atmosphere which is characteristic of the environment of the facility. When there is indication of a corrosive atmosphere on the Data Sheet (Annex A), the electronics shall receive a protective treatment called "coat" (complete covering with protective varnish).

5.3 Equipment shall have visual warning signs as to people accessing the internal components.

5.4 The rectifier case shall have the characteristics mentioned in 5.4.1 to 5.4.4, when it is not indicated on the Data Sheet of Annex A.

5.4.1 The minimum protection degree, as per ABNT [NBR IEC 60529](#), shall be IP-23, when installed in weather protected locations, or IP-43, when installed outdoors.

NOTE Equipment on off-shore facilities shall meet the recommendations of the Classification Societies.

5.4.2 Enclosure shall be made of carbon steel, stainless steel or aluminum, with anti-corrosive painting, in accordance with PETROBRAS [N-1735](#) and [N-1021](#).

5.4.3 The enclosure's finishing shall be in light gray color, code 0065 ("Munsell" N 6.5) on PETROBRAS [N-1219](#).

5.4.4 The rectifier shall be mounted on a removable chassis, and the enclosure shall be appropriate for securing it to a post, a wall or self-supported.

5.5 The rectifier shall have, in its metal structure, a window (collar) or a cable gland which is appropriate to the passage of electric wires. When the Data Sheet specifies "holes by the field", the rectifier shall be supplied with a removable cover flange.

5.6 The isolators of the bars, supports and junction parts shall be made of a non-hygroscopic and non-flammable material.

5.7 The rectifier shall have bonding (grounding) bus, according to ABNT [NBR 5410](#), located on the inside bottom of the rectifier.

5.7.1 All metal parts which make up the rectifier, and which are not for conduction of electricity, shall have electrical continuity and be individually connected to the bonding bus.

5.7.2 The bus shall have enough connectors for the connections provided in 5.7.1, as well as for the devices of protection, measurement, grounding of the electric utility and interconnection wire (rated section of up to 25mm²) with the local land mesh.

5.8 Externally to the rectifier, a nameplate shall be attached, made of corrosion resistant material (stainless steel or acrylic), with the following information:

- a) PETROLEO BRASILEIRO S/A – PETROBRAS or subsidiary;
- b) manufacturer name;
- c) rectifier model;
- d) rated electric characteristics (input voltage, frequency and phase number, output voltage, output current and power);
- e) total mass;
- f) manufacture date;
- g) serial number.

5.9 All rectifier components shall be duly and indelibly identified.

5.9.1 Additionally, on the rectifier output, the structures to which the terminals shall be interconnected shall be informed (positive terminal - anodes and negative terminal - structure to be protected).

5.9.2 The rectifier shall be provided with a copy of the electric diagrams, protected against humidity and mishandling, placed in a slot in the inner part of the door.

6 Electric Characteristics

6.1 The powered parts shall be protected against accidental touching.

6.2 All components shall be sized to support the electric insulation resistance test as per 7.2.

6.3 The efficiency of the equipment shall be equal to or higher than 60% for single-phased rectifiers and 80% for three-phased rectifiers, for a load ranging from 50 % to 100 % of its rated value.

6.4 The input transformer shall be dry with maximum temperature class B.

6.5 Selection of output voltage shall be performed:

- a) through thick and fine taps in the equipment manuals;
- b) through a control circuit in the automatic equipment.

6.6 An universal electric outlet, installed on the front panel with output voltage of 127 or 220 V_{ac}, may be required, in accordance with the Data Sheet of Annex A.

6.7 The rectifier shall have lighted signals in order to indicate powered equipment, located on the front panel of the equipment, with "Powered Equipment" written on it.

6.8 The rectifier shall have protections which inhibit its work in case of failures which could cause physical damage to the equipment.

6.8.1 Circuit breaker with thermal element for protection against overcurrent and rectifier switching, appropriate to the feed voltage.

6.8.2 Fuses of the NH-type to protect from input, output and the rectifier column.

6.8.3 Cylindrical fuses for instrument protection.

6.8.4 Surge protective devices for protection of input and output of land equipment, with the following characteristics:

- a) zinc oxide varistor (MOV) or gas-filled spark arrester (GCL) technology;
- b) continuous operation maximum voltage U_C: 275 V;
- c) minimum rated discharge current I_N (8/20 μs): 30 kA;
- d) failure signals.

6.8.5 Surge protective devices shall be installed:

- a) on rectifier input between each phase and the bonding bus;
- b) on equipment outlet between the positive and negative terminals, between the negative terminal and the bonding bus.

6.8.6 A Resistor-Capacitor (RC) Circuit for individual protection of each component of the rectifier column.

6.8.7 Additional protection may be required, in accordance with the Data Sheet of Annex A.

6.9 The rectifier shall contain measuring instruments with minimum accuracy class of 1,5 %. There shall be a local indication of output voltage, output current and operating hours. Models of indicators shall be specified on the Data Sheet of Annex A.

NOTE If the indicator supports multiple functions, the operation hours counter shall be redundant.

6.9.1 The local indication of the input voltage may be required, in accordance with the Data Sheet of Annex A.

6.9.2 The hourmeter (counter of operation hours) shall have a record of at least 05 whole digits. Counting shall be interrupted in case there is no output current from the rectifier.

6.9.3 The rectifier shall be provided with a shunt resistance, for output current measurement.

6.9.4 Local indication of the anodes individual output current may be required, in accordance with the Data Sheet of Annex A.

6.10 Each rectifier shall be provided with their spares parts:

- a) a complete set of protection devices: fuses, surge protective devices and RC circuit;
- b) set of diodes / thyristors.

6.11 Automatic Rectifier

6.11.1 The automatic rectifier shall allow manual and automatic operation.

6.11.2 In addition to the numbers mentioned on 6.9 there shall also be a local indication of the structure-electrolyte potential.

6.11.3 The automatic operation mode shall allow controlling of the structure-electrolyte potential from a preset reference value. The adjusting range of the reference potential and the amount of electrodes shall be as indicated on the Data Sheet of Annex A.

6.11.4 The reference value shall be shown on the equipment front panel.

6.11.5 The equipment shall have a output current and voltage limiting system to nominal values.

6.12 The rectifier shall enable, for remote monitoring, the structure-electrolyte potential, output voltage and output current analog variables, as well as the feed voltage existence state variable.

6.13 The rectifier for onshore facilities shall also have the equipment door opening state variable.

6.14 The rectifier for offshore facilities shall have under- and over-protection alarms, under- and over-current, feed failure and common alarm output (general). In addition, it shall have a record of the alarm occurrences and the structure-electrolyte potential, output voltage and output current analog variables.

7 Inspection and Tests

7.1 Dimensional and visual inspection shall be performed as well as checking of the moving parts of the rectifier (doors, chassis, etc.) and the painting (color, thickness and adhesion).

7.2 In accordance with ABNT [NBR 5410](#), the working and applied voltage, and the insulation resistance routine tests shall be performed.

7.3 The type tests shall be those shown in the Data Sheet of Annex A.


8 Documents Required


8.1 The technical proposal shall include the following documents:

- a) Data Sheet of Annex A duly completed;
- b) dimensional drawings with side, front, upper and lower views;
- c) rectifier catalog, containing components and accessories with all information and technical characteristics;
- d) spare part list;
- e) technical assistance network;
- f) information of validity period, which shall be at least 1 year;
- g) reference list of previous provisions.

8.2 Equipment shall be provided with the following documents:

- a) warranty certificate;
- b) instructions manual, which shall contain:
 - rectifier technical specifications, as well as for all required components and accessories;
 - dimensional drawings with all views, sections and details;
 - electric and electronic schematics;
 - list of components, detailing the manufacturer and the commercial reference;
 - procedures for storage, installation, preventive and corrective rectifier maintenance;
 - spare parts list;
- c) certificates of all tests to which the rectifier was submitted to after manufacturing.

 PETROBRAS	DATA SHEET		No.						
	CLIENT:			SHEET					
	JOB:			of					
	AEA:								
	TITLE:								
CATHODIC PROTECTION RECTIFIER									
INDEX OF REVISIONS									
REV.	DESCRIPTION AND/OR REVISED SHEETS								
	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE									
DESIGN									
EXECUTION									
CHECK									
APPROVAL									
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<small>FORM OWNED TO PETROBRAS N-2608 REV. B ANNEX A - SHEET 01/02.</small>									

		DATA SHEET		No.	REV.
		TITLE: CATHODIC PROTECTION RECTIFIER		SHEET	
				of	
1	QUANTITY:		5	ELECTRIC CHARACTERISTICS:	
2	MANUFACTURER / MODEL:		5.3	FREQUENCY:	Hz
3	ENVIRONMENTAL CHARACTERISTICS:		5.4	RATED OUTPUT VOLTAGE (DC):	V
3.1	INSTALLATION: <input type="checkbox"/> INDOOR <input type="checkbox"/> OUTDOOR		5.5	RATED OUTPUT CURRENT (DC):	A
3.2	CORROSIVE ATMOSPHERE: <input type="checkbox"/> YES <input type="checkbox"/> NO		5.6	RATED POWER:	kW
3.3	AMBIENT TEMPERATURE: °C		5.7	RATED EFFICIENCY:	%
4	CONSTRUCTIVE CHARACTERISTICS:		6	INDICATORS:	
4.1	TYPE: <input type="checkbox"/> MANUAL <input type="checkbox"/> AUTOMATIC		6.1	MODEL: <input type="checkbox"/> LCD <input type="checkbox"/> ANALOG <input type="checkbox"/> DIGITAL	
4.2	NUMBER OF TAPS (MANUAL): _____ FINE _____ THICK		6.2	ADDITIONAL INDICATIONS: <input type="checkbox"/> INPUT VOLTAGE <input type="checkbox"/> STRUCTURE/ELECTROLYTE POTENTIAL <input type="checkbox"/> INDIVIDUAL CURRENT BY ANODE	
4.3	ADJUSTING RANGE OF THE REFERENCE POTENTIAL (AUTOMATIC): _____ to _____ mV		7	TYPE TESTS:	
4.4	COOLING: <input type="checkbox"/> AIR <input type="checkbox"/> OIL			<input type="checkbox"/> TRANSFORMER TEMPERATURE RISE <input type="checkbox"/> YIELD <input type="checkbox"/> POWER FACTOR <input type="checkbox"/> ENCLOSURE PROTECTION DEGREE <input type="checkbox"/> DIODE/THYRISTOR CASE TEMPERATURE RISE	
4.5	ENCLOSURE: 4.5.1 DEGREE OF PROTECTION IP: _____ 4.5.2 MATERIAL: <input type="checkbox"/> CARBON STEEL <input type="checkbox"/> STAINLESS STEEL <input type="checkbox"/> ALUMINUM 4.5.3 SECURING: <input type="checkbox"/> POST <input type="checkbox"/> WALL <input type="checkbox"/> SELF-SUPPORTED		8	COMPLEMENTS:	
4.6	TOTAL WEIGHT: 4.6.1 W/O OIL: _____ kg 4.6.2 WITH OIL: _____ kg		8.1	ACCESSORIES FOR INSTALLATION: <input type="checkbox"/> ANGLE BRACKETS <input type="checkbox"/> CLAMPS <input type="checkbox"/> ANCHOR BOLT	
4.7	INPUT AND OUTPUT OF ELECTRIC WIRES: <input type="checkbox"/> WINDOW (COLLAR) <input type="checkbox"/> CABLE GLAND <input type="checkbox"/> HOLES MADE IN FIELD		8.2	ADDITIONAL ELECTRIC PROTECTION. INDICATE:	
4.8	POWER CABLES QUANTITY: RATED SECTION: _____ mm²		8.3	Nr. OF INPUTS FOR REFERENCE ELECTRODES:	
4.9	POSITIVE WIRES (DC) QUANTITY: RATED SECTION: _____ mm²		9	NOTES	
4.10	NEGATIVE CABLES (DC) QUANTITY: RATED SECTION: _____ mm²				
5	ELECTRIC CHARACTERISTICS				
5.1	INPUT VOLTAGE (AC): _____ V				
5.2	NUMBER OF PHASES:				
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INDEX OF REVISIONS

REV. A

Affected Parts	Description of Alteration
All	Revised

REV. B

[illegible]