SOUTHWEST GAS CORPORATION
ENGINEERING STAFF

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MATERIAL SPECIFICATION

Prepared By: Engineering Staff

Approved By: Jerome T. Schmitz

CORROSION CONTROL MATERIALS
Rectifier – Cathodic Protection

1. SCOPE

This specification defines the minimum requirements for semi-conductor rectifiers used to cathodically protect underground pipelines. Two types of power source (rectifiers) are described in this material specification and include the "standard" rectifier and the "utility" transformer rectifier. The standard rectifier is a manually controlled power source that provides DC current to a separate anode cable junction box. The utility rectifier is a manually controlled power source that provides DC current to an integrated anode cable junction box.

2. APPLICABLE DOCUMENTS

2.1 American National Standards Institute (ANSI)/American Society for Quality Control (ASQC) Z-1.4, "Sampling Procedures and Tables for Inspection by Attributes."

2.2 National Electric Manufacturers Association (NEMA) 250 "Enclosures for Electrical Equipment (1000 Volts Maximum)."

2.3 Underwriters Laboratories, Inc. (UL) Style 1015 of Standard 758, "Appliance Wiring Material."

2.4 United States Department of Transportation (DOT), Code of Federal Regulations (CFR), Title 49, Part 192, "Transportation of Natural and Other Gas by Pipeline; Minimum Safety Standards."

NOTE: Unless otherwise specified, the editions of the above document incorporated in whole or in part by 49 CFR 192 are applicable. The above documents, and parts of documents (including annexes), not incorporated by 49 CFR 192 are incorporated by this Material Specification and will be the most recent edition. If a conflict exists between the applicable documents and/or this Material Specification, the requirements of 49 CFR 192 shall govern, and if all other conflicts, the more stringent requirement shall govern.

3. TERMINOLOGY

3.1 General

3.1.1 "Southwest Gas," "Southwest" or "SWG" wherever used in this specification and other related documents will refer exclusively to Southwest Gas Corporation.

3.1.2 The terms "approved," "as approved," "satisfactory," "as directed," "or equal" or other similar terms wherever used in this specification and other related documents will mean "as determined by Southwest Gas," unless specifically stated otherwise.

3.1.3 "Product Information Package" or "PIP" wherever used in this specification and other related documents will mean the required technical product information that a manufacturer must submit to SWG to determine if the product is suitable for use by SWG, unless specifically stated otherwise.

4. MATERIALS AND MANUFACTURING

4.1 Standard materials and manufacture that are common to both the standard rectifier and the utility rectifier include the items outlined below:

4.1.1 The rectifiers will meet the requirements of the latest editions of the electrical codes of Federal, state and local agencies and any other applicable codes.

4.1.2 The rectifier elements will be mounted to an extruded gold chromate aluminum heat sink. The heat sink is to be mounted to a grade "XN" phenolic panel to insulate from rectifier back pan.

4.1.3 The A.C. and D.C. connections shall be made with screw connections; fast-on terminals are not acceptable.

4.1.4 All wire connections shall be of the insulated type.

4. MATERIALS AND MANUFACTURING (Cont'd)

4.1

4.1.5 Flexible stranded copper wire leads with cross-link P.E. insulation rated for 600 volts at 105 °C (ambient temperature) shall be provided using the following color code to indicate proper polarity.

- Yellow, A.C.
- Red, D.C. Positive
- Black, D.C. Negative

4.1.6 Flexible stranded copper wire shall be used throughout the rectifier. Wire shall be 19-strand, tin coated copper, conforming to the requirements of UL Style 1015.

4.1.7 Suppressor leads shall be flexible stranded copper wire with Teflon insulation rated 105°C (ambient temperature) or equal.

4.1.8 Two surge suppressors will be provided as follows:

- One surge suppressor for A.C input to the stack
- One surge suppressor for the D.C. output of the stack.

4.1.9 The transformer core will be made of grade M-6 high silicon grain-oriented steel or equivalent.

4.1.10 The control panel will be hinged on the left side and secured on the right side by a 1/4 – 20 PEM screw assembly.

4.1.11 A separate pivot jeweled movement voltmeter and ammeter will be provided and include the following requirements:

- The voltmeter will have an internal resistance of 1000 ohms/volt.
- The calibration resistor will be mounted internally.
- The ammeter will have a full scale of 50 millivolts complete with external panel mounted shunt with its rating clearly marked and engraved on the control panel.
- Both the voltmeter and the ammeter will be redlined at the rated output of the rectifier.

4. MATERIALS AND MANUFACTURING (Cont'd)

The A.C. lightning protection circuit will be provided with an expulsion type lightning arrestor rated for 175 volts to ground.

4.1.12 The D.C. lightning protection circuit will be provided with a varistor-type lightning arrestor mounted on the control panel.

4.1.13 The rectifiers will be provided with two each fully magnetic circuit breakers located as follows:

- A.C. secondary leg; one each
- D.C. negative output leg; one each

4.1.15 All circuit breakers will be clearly marked and engraved as follows:

- A.C. secondary
- D.C. negative

4.1.17 A wiring diagram, parts list and test data sheet will be furnished with each rectifier.

4.1.18 Louvers with screens will be provided in the enclosure for adequate convection air cooling in the line with the temperature rating of the rectifier.

4.1.19 The enclosure will be equipped with a stainless-steel lockable draw-pull latch.

4.1.20 When specified, conduit entries will be provided.

4. MATERIALS AND MANUFACTURING (Cont'd)

4.2 This section outlines the requirements for the standard rectifier unit required by SWG.

4.2.1 The standard rectifier transformer shall be designed with a dual primary input of 120/240 V.A.C. and a secondary winding having 5 coarse and 10 fine taps yielding a total of 50 D.C. output adjustments.

- The separate primary and secondary copper windings will be designed for 60 Hertz at 50°C ambient temperature.
- The transformer shall be class "H" varnish impregnated and oven baked to a dry condition with a stamped name tag showing primary voltage, secondary voltage, K.V.A. rating and serial number.
- The transformer A.C. primary leads will be flexible stranded copper wire with cross-ink PE insulation same as in the rectifier element and must be terminated by means of No. 10 solder stud lug to a fully engraved grade XX phenolic primary board.
- The primary board will be labeled 120/240/120 with appropriate buss bars to change from 120 to 240 V.A.C. service without splicing.
- A clear Lexan® cover or equivalent will be provided on primary taps and engraved "WARNING HIGH VOLTAGE" to warn against accidental shock.
- A 3-point screw type terminal block will be added for termination of the incoming A.C. service.
- The terminal block will be wired with 24-inch long stranded copper color coded leads rated for 600-volt service conforming to the requirements of UL Style 1015.

4. MATERIALS AND MANUFACTURING (Cont'd)

4.2.2 Color coding for units designed to operate on 120 V.A.C, service will be as follows:

- Black for line (hot leg), 1 each
- White for neutral, 1 each
- Green for ground, 1 each

4.2.3 Color coding for units designed to operate on 240 V.A.C. service will be as follows:

- Black for line (hot legs). 2 each
- Green for ground, 1 each

4.2.4 The transformer A.C. secondary leads will be flexible stranded copper wire with cross-link PE insulation same as the primary leads and must be terminated by means of 1/4-Inch X 2-Inch brass solder stud lugs to a fully engraved grade XX phenolic control panel.

4.2.5 The standard rectifier output adjustments will be accomplished by a link bar arrangement mounted on the control panel clearly marked as follows:

- Letters A thru E engraved on the control panel for the fine adjustments.
- Numbers 1 thru 10 engraved on the control panel for the fine adjustments.
- Each link bar will be secured with 1/4-Inch brass wing nuts.

4.2.6 A fully magnetic circuit breaker will be provided for:

- 1 each single-pole breaker for 120-volt operations, or
- 1 each double-pole breaker for 240-volt operations

4.2.7 The control panel will be manufactured to accommodate either a single pole or double pole breaker.

4. MATERIALS AND MANUFACTURING (Cont'd)

4.2.8 If the unit is wired for 120 V.A.C. then a single pole breaker and blank cover plate shall be provided.

4.2.9 The rectifier enclosure will meet the requirements of NEMA 250 for outdoor operations and fabricated from 0.09-Inch (14 GA). 5052-H/32 anodized or marine grade 5052 aluminum complete with a finish coat of white or tan baked-on enamel and will have the following:

- Internal removable pans and brackets shall be furnished in the same manner as the rectifier enclosure.
- Complete rectifiers (enclosures and removable pans) will be constructed where the front, sides, top and bottom of the enclosure housing swing open and are removable so that the component chassis is easily accessible and removable.

4.2.10 The enclosure will have a minimum of the following:

- 3-Inch extruded aluminum channel bolted to the back for pole mounting
- The channel will run the entire length of the enclosure and will be cut off flush with the top and bottom of the enclosure.
- Mounting holes will be drilled through the back pan and the channel for pole mounting.
- The back pan will be mounted to the channel with two 5/16-Inch, 18 drilled and tapped holes in the channel.
- A minimum depth of 4-Inches is required for the back pan.

MATERIAL SPECIFICATION

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CORROSION CONTROL MATERIALS
Rectifier – Cathodic Protection

4. MATERIALS AND MANUFACTURING (Cont'd)

4.2.11 A duplex 115VAC+GFI receptacle (Hubbell GFR-5252-1A or approved equal) will be mounted in the following manner:

- In a non-metallic enclosure (Carlon E980DFN or approved equal) and bolted to the front right corner of the rectifier body/door on the side next to the hinges.
- Type SO 3-strand copper cable (SO-123 or approved equal) will be used to wire the 115VAC+GFI receptacle to a 4-position terminal block in the "Rectifier Backpan" for field connection of AC power.
- The SO cabling into the non-metallic enclosure shall be through a cord-grip connector (Carlon LH21 or approved equal) and female adaptor (Carlon E942D or approved equal) through the top of the non-metallic enclosure.
- The Type SO cable will be run up the corner seam of the body/door, brought over the hinged portion of the cabinet and brought back down to the 4-position terminal strip on the rectifier back pan. Cable restraints will be used to hold cord in place and prevent interference with opening/closing of the cabinet.

4.3 This section outlines the requirements for the utility rectifier unit required by SWG.

4.3.1 The transformer for the utility shall be designed with primary input of 120 VAC and a 2-lead secondary winding output connected to a 100 percent variable output transformer.

- The separate primary and secondary copper windings will be designed for 60 Hertz at 50°C ambient temperature. The transformer will be Class H varnish impregnated and oven baked to a dry condition with a stamped name tag showing primary voltage, secondary voltage, K.V.A. rating and serial number.
- The transformer AC primary leads will be flexible stranded copper wire with cross-link PE insulation same as in the rectifier element and must be terminated by ring terminal connections to the Dial-Adjust "Variac" variable transformer (0 to 100% adjustment).

4. MATERIALS AND MANUFACTURING (Cont'd)

4.3.1 (Cont'd)

- A 3-point screw type terminal block will be added for termination of the incoming AC service. A clear Lexan® cover or equivalent will be provided on primary taps and engraved "WARNING HIGH VOLTAGE" to warn against accidental shock.
- Terminal block will be wired with 24" long stranded copper leads that are color-coded and rated for 600v service conforming to requirements of UL Style 1015.

4.3.2 Color coding for units designed to operate on 120 VAC service will be:

- Black for line (hot leg), 1 each
- White for neutral, 1 each
- Green for ground, 1 each

4.3.3 The transformer AC Secondary leads will be flexible stranded copper wire with cross-link PE insulation same as the primary leads and must be terminated by ring terminal connections to the AC Secondary connections on the Silicon Modular Bridge.

- The rectifier output adjustments will be accomplished by a dial adjust "Variac" variable transformer (0 to 100% adjustment).
- A fully magnetic single-pole circuit breaker for 120 VAC operations will be provided.
- The control panel will be manufactured to accommodate a single pole breaker.
- Fully magnetic circuit breakers will be mounted on the control panel. They will be installed on the secondary AC and negative DC output.

4. MATERIALS AND MANUFACTURING (Cont'd)

4.3.4 The rectifier enclosure will meet the requirements of NEMA 250 for outdoor operations and fabricated from 0.125-inch (11) gauge. 5052-H/32 anodized or marine grade 5052 aluminum complete with a finish coat of white or tan baked-on enamel. The enclosure will have the following:

- Internal removable pans and brackets will be furnished in the same manner as the rectifier enclosure.
- Complete enclosure will be constructed with a hinged/removable front door. The rectifier control panel will be hinged so the component chassis is easily accessible and removable.
- The enclosure will have a minimum 3-inch formed 0.125-gauge aluminum channel bolted to the back for pole mounting.
- The channel will run the entire length of the enclosure and will extend 3-inches above and 3-inches below the top and bottom of the enclosure.
- Mounting holes will be in a keyhole shape in the top of channel and an oblong hole in the bottom of channel.
- The back pan will be mounted to the channel with two 5/16-inch X 18 drill and tapped holes in the channel.
- A minimum depth of 8-inches is required for the back pan and junction box panel.

4.3.5 The junction box component panel will consist of the following items:

- The component panel will be a fully engraved Grade XX phenolic.
- The junction box panel will be mounted directly below the rectifier back pan, in the combined enclosure.

4. MATERIALS AND MANUFACTURING (Cont'd)

4.3.5 (Cont'd)

- A 1/16" X 3/4" (0.16 X 1.9 cm) copper buss bar will be provided to accommodate five each Holloway type "JB" current shunts and five will be adjusted to the minimum resistance position. The buss bar will be mounted on the back side of the phenolic panel.
- Teflon stranded No. 18 gauge copper wire (minimum) will be used for all internal wiring of the anode terminal panel.
- The terminals and mechanical lugs for the rectifier negative header cable, reference electrode lead and the cathode reference lead will be installed in the lower right corner of the panel. All terminal leads must clearly be identified by engraving on the component panel.
- The mechanical lugs for all terminations will be made of copper and uniformly tin plated to prevent atmospheric corrosion.
- All nuts, bolts and washers will be made of brass or silicon bronze.
- All bolts passing through the phenolic panel will have an internal tooth, shaker-proof phosphorus-bronze lock washer installed on each side of the panel.

4.3.6 The DC "Positive" and "Negative" connections between the rectifier and junction box panel will be made at the factory and will have the following requirements:

- A duplex 115VAC+GFI receptacle (convenience outlet) will be mounted in the Junction Box Panel portion of the unit.

4. MATERIALS AND MANUFACTURING (Cont'd)

4.3.6 (Cont'd)

- The 115VAC+GFI receptacle (Hubbell GFR-52521A or approved equal) will be mounted in a non-metallic enclosure (Carlon E980DFN or approved equal). It will be bolted to the back of the rectifier enclosure rectangular cut-out will be made in the Junction Box Panel to allow access to the receptacle, but not interfere with the connections and wiring to the Junction Box Panel output terminals.

4.3.7 A rectangular cut-out (suitable for the receptacle) shall be made in the Junction Box Panel to allow access to the receptacle, but not interfere with the connections and wiring to the Junction Box Panel output terminals.

4.3.8 Type SO 3-strand copper cable (SO-123 or approved equal) shall be used to wire the 115VAC+GFI receptacle to a 4-position terminal block in the "Rectifier Backpan" for field connection of 120v AC power. The SO cabling into the non-metallic enclosure will be through a cord-grip connector (Carlon LH21 or equal) and female adaptor (Carlon E942D or approved equal).

4.3.9 All wire connections will be of the insulated type.

5. PERFORMANCE REQUIREMENTS

5.1 The rectifiers will meet the requirements of NEMA 250 for weather proof housing used in operations outdoors in an ambient air temperature of 140 °F (60 °C) and shall meet further requirements of this specification.

5.2 The standard rectifier input will be rated at 120/240 V.A.C., single phase, 60 cycles unless otherwise specified.

5. PERFORMANCE REQUIREMENTS (Cont'd)

5.3 The standard rectifier element will be of silicon modular full wave bridge construction capable of operating at a case junction temperature of 243°F (117°C) rated for the following:

- 0-25 amps output: 30 amps at 1600 peak reverse voltage.
- 25-30 amps output: 2 each half-wave modular elements (semi-pak) rated for 100 amps at 1600 peak reverse voltage.

5.4 The utility rectifier maximum DC output will be rated for 50 Volts at 8 Amps.

5.5 The utility rectifier element will be of silicon modular full wave bridge construction capable of operating at a case junction temperature of 243°F (117°C) rated for 0 to 25 amps output: rated at 30 amps at 1600 peak reverse voltage.

5.6 Each rectifier must operate continuously at rated output for a minimum of 2 years.

5.7 In the event of failure of a rectifier to operate continuously for a minimum of 2 years due to defective part or craftmanship, parts will be furnished free of charge to SWG to replace those that are defective.

6. DIMENSIONS AND TOLERANCES

6.1 The voltmeter and a meter shall have a full-scale accuracy of +/-2%.

6.2 Surge suppressors shall be 130 volt-20 joule devices and shall be wired to a 4-point terminal block with screw type connections.

6. DIMENSIONS AND TOLERANCES (Cont'd)

6.3 The control panel must be of adequate dimensions to contain the following:

- A.C. circuit breaker
- Indicating meters
- Panel shunt
- Fully magnetic circuit breakers
- D.C. lightning arrestor
- D.C. output terminals

6.4 All wire shall be sized to 500 circular mils per AMP minimum.

6.5 The back-mounting plate shall be fabricated per Figure 1 in Appendix A.

6.6 The air-cooled rectifier case shall be per Figure 2 in appendix B.

7. INSPECTION

7.1 Successful review of the Product Information Package (PIP) as well as any future reference by SWG to the seller's part number or internal code number in any future contract or purchase, will mean only that no conflict with the specification was found and will not relieve the seller from meeting all the requirements of this specification.

7.2 SWG retains the option to inspect the manufacture and testing of all materials, products or systems referenced in this specification that are sold to SWG.

7.3 SWG will have the right, at their option, to reject any material, which fails to conform to this specification. Any such rejection may take place at the manufacturer's facility; the supplier's warehouse or any subsequent delivery location, before or after SWG assumes possession. Notice of the rejection will be made promptly to the supplier by SWG. The defective product will be replaced or returned for credit at the manufacturer's expense.

7.4 Any changes in manufacturing of previously approved products covered under this document for sale to SWG must be approved by SWG Engineering Staff. **Failure to obtain SWG approval may be cause for rejection and disqualification as an approved supplier.**

8. CERTIFICATION

The manufacturer's or supplier's certification shall be furnished to Southwest. This certification shall state that samples representing each lot have been manufactured, tested and inspected in accordance with this specification and that requirements have been met. When requested or specified in the purchase order or contract, a report of test results will be provided.

Upon the request of Southwest, the certification of an independent third party indicating conformance to the specification may be considered at Southwest's expense.

9. SAFETY DATA SHEETS

In accordance with law, the seller shall supply Safety Data Sheets for all applicable items supplied under this specification to the following:

1) The Receiving Location

2) Engineering Staff

3) Southwest Gas Corporation
Staff Safety
Mail Station LVA-120
P.O. Box 98510
Las Vegas, NV 89193-8510

10. PRODUCT MARKING

Each rectifier shall be equipped with a manufacturing data name plate readily visible after installation with:

- Manufacturer's name or trademark
- Manufacturer's part number
- Rated output voltage and current

Southwest retains the right to require the rectifiers to be marked with Southwest's purchase order number and/or head code identity.

11. PACKAGING AND PACKAGE MARKING

All products covered in this specification will be packaged to prevent damage during transportation and storage.

12. STOCK CLASSIFICATION DESCRIPTION

RECTIFIER, _____ AMP, AIR COOLED 50 VOLT, WITH WEATHERPROOF HOUSING, _____ VOLT INPUT.

RECTIFIER, _____ AMP, AIR COOLED 50 VOLT, WITHOUT WEATHERPROOF HOUSING, OLD STYLE, _____ VOLT INPUT.

UTILITY RECTIFIER, _____ AMP, AIR COOLED, 50 VOLT, WITH WEATHERPROOF HOUSING AND INTEGRATED ANODE JUNCTION BOX, _____ TERMINALS, _____ VOLT.