CATHODIC PROTECTION
RECTIFIER SPECIFICATION

BENCHMARK AIR-COOLED LINE

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This specification shall outline the features of the Integrated Rectifier Technologies, Inc. Benchmark Air-Cooled line of Cathodic Protection Rectifiers.

1.0 GENERAL

1.1 The Benchmark line rectifiers are manufactured in accordance with the following applicable standards:

a) Canadian Standards Association (CSA) Specifications:
C 22.2 / No. 0 – General Requirements
C 22.2 / No. 66 – Specialty Transformers
C 22.2 / No. 94 – Special Purpose Enclosures
C 22.2 / No. 107 – General Use Power Supplies
b) National Electrical Manufacturers Association (NEMA) Standard No. 250.
c) Canadian Electrical Code (CEC) & National Electrical Code (NEC).

1.2 The rectifiers are designed to meet or exceed the National Association of Corrosion Engineers (NACE) criterion for Cathodic Protection use.

1.3 The Benchmark line rectifiers are typically available with a 115, 230, or 115 / 230 Volt, single-phase AC input at an input frequency of 60 Hz. Other inputs may be optionally available. The rectifier shall be designed to provide rated DC output with an AC input at 5% below the nominal level specified and such that an AC input of 10% above nominal AC input voltage shall not damage any rectifier components.

1.4 The rectifiers are designed to operate in an ambient range of –50°C (-58°F) to +45°C (113°F). An extended temperature range may be optionally requested.

2.0 ENCLOSURE

2.1 The Benchmark air-cooled line enclosures are constructed in accordance with CSA requirements for outdoor weatherproof, “Type 3R” enclosures. This shall be equivalent to NEMA 3R standards.

2.2 The Benchmark line enclosures are constructed from 14 or 12 gauge wiped coat, mill galvanized steel and finished with 3-5 mils of white, fusion bond, polyester powder paint. The enclosures are vented to allow for natural air convection and all openings shall be screened against insects and debris. The enclosures are supplied with suitably sized wall / pole mounting brackets and also, suitably sized conduit knockouts (on the bottom rear) to allow for connection of AC and DC field cabling. The single, front opening door of the enclosure is hinged on the left side and has a heavy duty, lockable draw latch on the right side that will accept a maximum 3/8” (9.5mm) padlock. The draw latch is constructed of zinc dichromate plated steel or optionally, of Series 300 stainless steel. For larger sized enclosures, two front doors are provided with the draw latch in the center. The enclosures are designed to allow for a single, easily removable rear panel chassis type rectifier assembly. All enclosure fasteners are fabricated from stainless steel.

3.0 CONTROL METHOD

3.1 The Benchmark air-cooled rectifiers are designed for manual, Constant Voltage control via 25 steps (5-Coarse & 5-Fine) of transformer secondary tap adjustment. A larger

number of tap adjustment steps may be optionally available. The tap adjustment method for the Benchmark air-cooled line of rectifiers shall be via a tap terminal block, easily accessible from the front of the rectifier unit.

4.0 MAIN TRANSFORMER / ADJUSTMENT

4.1 The Benchmark air-cooled rectifiers are equipped with a full isolation type, secondary tap adjusted transformer.

4.2 The transformer is designed to operate properly at 115% of the specified rated output to allow for reserve capacity.

4.3 The main transformer is equipped with separate, isolated primary and secondary windings. The transformer windings are constructed from heavy polythermaleze (HPTZ) insulated magnetic wire with a minimum cross sectional area of 800 circular-mils per ampere of rated current. The transformer core is constructed from interleaved, “E” & “I” type, grain-oriented steel laminations for maximum permeability. For transformers utilizing 29 gauge laminations, a design calculation for a maximum flux density of 13,000 gauss is used. For transformers utilizing 26 gauge laminations, a design calculation for a maximum flux density of 11,500 gauss is used. Maximum core losses are limited to 0.7 watts per pound or less. The transformer efficiency shall be no less than 94% and voltage regulation from a “no load” to a “full rated load” condition shall not exceed 5%. The transformer core and coil are constructed from materials with a Class “H” (180°C) operation rating. The transformer lead wires are sized for a minimum cross sectional area of 500 circular-mils per ampere of rated current. The transformer lead wires are silver brazed to the coil magnet wire, taped, and covered with Class “H” silicon impregnated sleeving.

4.4 After fabrication, the transformer shall successfully pass a dielectric strength test, as per CSA Standard requirements, between the primary and secondary windings and between each winding and the lamination core.

4.5 The transformer dielectric and thermal properties are further enhanced by dipping in a thermo-setting varnish (Class “H”) until the entire body of the transformer is saturated. The transformer is then oven baked for a suitable period until such time that the varnish coating has hardened to provide a suitable environmental seal.

5.0 INSTRUMENT PANEL

5.1 The instrument panel for Benchmark line rectifiers is constructed from a minimum of 0.1875” NEMA Grade “XX” laminated phenolic, rated for Class “B” (105°C) operation.

6.0 RECTIFYING DEVICES

6.1 The rectifier circuit consists of individual silicon diodes arranged into a full wave bridge configuration or a single molded diode bridge module. The diodes are sized for approximately 200% of the nominal current through each device at rated rectifier output. All diodes are sized for a minimum Peak Inverse Voltage (PIV) rating of 300% of the voltage impressed on each device, or 600 volts, whichever is greater. Diodes with a higher PIV rating are available on request.

6.2 The diodes or molded diode bridge module are mounted to a suitable sized heatsink(s). The heatsinks are fabricated from either gold or black anodized aluminum to enhance the thermal transfer of the heat generated by the diode to the ambient air. All heatsinks are sized to ensure that the case temperatures of the diodes do not exceed 100°C at rated ambient and rated rectifier DC output. The heatsink assemblies are constructed to allow for proper diode cooling via natural air convection. Fan cooling is not permitted.

6.3 The rectifying devices are constructed into a modular assembly to allow for ease of any possible field maintenance.

6.4 For ambient temperatures above 45°C, all diodes are oversized as required and in accordance with manufacturers design recommendations.

7.0 MONITORING COMPONENTS

7.1 The Benchmark line rectifiers are constructed with a single analog meter connected to a toggle switch for monitoring of the rectifier DC output voltage and current. The meter is a minimum of 3.5” rectangular type with a scale length of 2.875”. Meter scales are of a metallic or plastic type and are mechanically affixed to the meter. Adhesive paper type scales are not acceptable. The standard metering utilized is the Yokogawa Model 260 Series (or equivalent) with a 50mV full-scale-deflection (FSD) utilizing a taut-band type movement with “four-to-one swamping”. This means that the internal meter resistance is comprised of 25% coil winding resistance and 75% fully temperature compensated dropping resistor resistance, which provides for superior temperature range performance. The taut-band type movement allows for greater meter sensitivity and improved shock resistance. The metering accuracy shall be 2% of FSD and shall comply with the requirements of ANSI C39.1. The metering scales are selected such that the rated output indicator (red-line or shading) is within a range of 70% – 95% of the FSD of the meter scale.

7.2 Optional digital metering is available for certain applications requiring improved accuracy and resolution. The digital meters utilized are Summit Model SI469 Series (or equivalent) with a meter accuracy of 0.1% $\pm$2 digits with a sample rate of 3.4 per second. These meters shall provide a 3.5 digit display and 0.56” high intensity numerals.

7.3 For applications where the rectifier is required to have multiple DC output circuits, rotary type metering switches are utilized and are environmentally enclosed against dust. The toggle and rotary type switches are designed to allow for a duty life in excess of 25,000 operations. For areas where the rectifier will be subject to a particularly corrosive or gaseous atmosphere, it is not recommended to use meter switches. For these locations, we recommend that the Benchmark line rectifier should be requested with an upgrade to separate, continuously reading meters or have all switch connections soldered and utilize completely sealed switches.

7.4 The rectifier ammeter receives a millivolt input from a “block” style shunt resistor located on the front of the instrument panel. The standard shunt utilized is a Holloway Type “SW” shunt with an accuracy of 0.25%. The shunt is clearly marked with the current and millivolt rating.

8.0 PROTECTIVE DEVICES

8.1 The Benchmark line rectifiers are constructed with a fully magnetic AC input circuit breaker to provide “OFF-ON” control, short-circuit protection, and input overload protection. The circuit breaker is of the manually reset type and is supplied with 1 pole per line of AC power input. The circuit breaker has a time delay rating sufficient to avoid false tripping due to transformer in-rush current or other minor transients. The circuit breaker is sized for the next industry standard current rating above the maximum AC input current rating of the rectifier. For dual input type rectifiers, preference will be given to the highest input load condition (i.e. lowest input voltage).

8.2 The Benchmark line rectifiers are constructed with fast acting fusing in one line of the AC secondary of the transformer. This fusing provides protection for the rectifier components against output short circuit or overload conditions. For certain applications, time delay type fusing may be used to avoid fuse operation caused by minor transients. The fusing is sized to allow for proper rectifier operation up to 110% of rated output. In all instances, a spare shall be supplied for each fuse utilized in the rectifier.

8.3 The Benchmark line rectifiers are protected against lightning and other surges by Metal Oxide Varistor (MOV) devices. The rectifier AC input is protected by a disk style MOV with a minimum extreme surge duty rating of 8 KA, based on a 8X20us wave, and an AC voltage rating that corresponds to the nominal AC input rating of the rectifier shall be used. The rectifier DC output is protected by a disk style MOV with a minimum extreme surge duty rating of 8 KA, based on a 8X20us wave, and a DC voltage rating as close as practical to the maximum peak voltage output rating of the rectifier. The DC surge arrestor is sized such that it conducts the surge current and clamps the transient voltage at a level below the PIV rating of the diodes. Optional high energy surge arrestors are available for rectifiers that are to be installed in an area that may be subject to frequent transients or surges. The bridge diodes are protected from surges by a disk style MOV with a minimum extreme surge duty rating of 8 KA, based on a 8X20us wave, across the AC input to the bridge

9.0 ELECTRICAL CONNECTIONS

9.1 The AC input terminals for the Benchmark line rectifier are provided via a terminal block located on the lower portion of the rear rectifier chassis. The AC input terminals are clearly labeled to indicate the location for the input wire connection and the rating of the AC input for the rectifier. Additional terminals are provided for dual AC input type units to allow for proper configuration of the AC input. A suitably sized electrical barrier is installed over the AC input terminals, as required, to prevent accidental contact with AC line voltages and is fitted with a warning label.

9.2 The DC output terminals for the Benchmark line rectifier are compression type lug terminals suitably sized for the rated DC output current of the rectifier. Non-standard size lug terminals may be optionally requested. The DC terminals are located on the lower front of the instrument panel and typically labeled as “ANODE (+)” and “STRUCTURE (-)”.

9.3 The rectifier is equipped with an extra terminal on the AC input terminal block to allow for connection of an electrical grounding wire.

9.4 All electrical wiring within the rectifier is CSA Type TEW wire with a temperature rating of 105°C or Type Exane cable with a temperature rating of 110°C. The wire is sized as per the manufacturers recommendations for the maximum current through the wire.

9.5 All electrical hardware used within the Benchmark line rectifiers is copper or brass with an electroless nickel-plating for superior atmospheric corrosion protection. All electrical connections utilize the “double-nut” method of fastening resulting in all electrical connection points being compressed between two nut / lockwasher assemblies. No electrical connections will rely on the compression properties of the panel material to maintain a secure connection. All electrical studs and connection bars are suitably sized for the maximum rated current through them.

10.0 DOCUMENTATION & LABELING

10.1 The rectifier shall be provided with a permanently imprinted nameplate with the following information:

a) Manufacturer Name
b) Model Designation
c) Serial Number
d) AC Input Voltage
e) AC Input Current
f) AC Input Frequency / Phase
g) Rated DC Output Voltage
h) Rated DC Output Current
i) Maximum Operating Ambient (°C)
j) Enclosure Type

10.2 The components on the front of the instrument panel are identified via vinyl adhesive labels with black lettering on a white background, silk-screening or by 1/16” lamicoid (plastic laminate), adhesive type labels with white lettering on a black background. For rectifiers that are to be installed in a high humidity or high temperature environment, the lamicoid adhesive labels are mechanically affixed via stainless steel screws or drive screws.

10.3 Each rectifier is supplied with a comprehensive data package, enclosed in a waterproof envelope and placed in a document holder pocket on the inside of the enclosure door. The data package includes a manual with details on installation, general operation, maintenance, and troubleshooting tips. A detailed electrical schematic and a parts / data page are also provided. Formalized rectifier test results (detailed below) may be optionally requested for inclusion in the data package.

11.0 TESTING AND QUALITY CONTROL

11.1 Each rectifier main transformer is subject to and has successfully passed the following electrical performance tests prior to installation into a rectifier unit.

a) Excitation current and no-load secondary voltage.
b) Voltage, current, and conversion efficiency at rated load.
c) Voltage, current, and conversion efficiency at 115% of rated load.

11.2 Each rectifier is thoroughly mechanically inspected; both during and after the manufacturing process, to ensure that the specification parameters indicated previously have been adhered to. Any discrepancies are documented, reviewed and corrected prior to electrical testing. Overall workmanship quality is also reviewed.

11.3 Each rectifier is subject to dielectric strength testing as per CSA Standard requirements and successfully passes this testing prior to further electrical testing.

11.4 Each rectifier is subject to and successfully passes the following electrical performance tests at rated DC output prior to release for final packaging.

a) AC input voltage and current.
b) Apparent power, effective power, & power factor.
c) DC output voltage, current, wattage, and ripple voltage.
d) Overall conversion efficiency.

11.5 Each rectifier meter is checked for calibration accuracy to ensure the specifications indicated previously have been met.

11.6 After installation into the required enclosure, the rectifier is subject to a final overall inspection including:

a) Documentation and labeling.
b) Overall construction.
c) Protective barriers.
d) Adherence to the general specification and customer specific requirements.