

Single-Phase Step Voltage Regulator

- Pad-Mounted -

With a Communication-Ready Control Panel



Table of Contents

1	GENERAL	4
2	CONSTRUCTION.....	4
3	RVI REQUIREMENT.....	7
4	REGULATOR CONTROLS.....	Error! Bookmark not defined.
5	TESTS	9
6	EVALUATION	10
7	CONTROL INTERROGATION SOFTWARE	10
8	DEVIATION FROM SPECIFICATION	11
9	SHIPPING INSTRUCTIONS.....	11
10	APPENDIX A – EQUIPMENT DATA SHEET	12
11	APPENDIX B – DEVIATIONS FROM SPECIFICATIONS.....	13



Material Specifications

Date 9/21/2020

Rev. 0

Standard No.

1211.03

Single-Phase Step Voltage Regulator – PAD

With a Communication-Ready Control Panel

Page 3 of 13

1 GENERAL

1.1 This specification covers electrical, mechanical, and safety features and characteristics of outdoor, pad-mounted, single-phase, oil immersed, 60 Hz, 65°C temperature rise by resistance, self-cooled step-type voltage regulators. The voltage regulator must be completely self-contained and provide $\pm 10\%$ regulation in thirty-two (32) steps of approximately 5/8% each. The voltage regulator shall be of a sealed tank design that will allow operation at 65°C without increasing the oxidation rate of the oil.

1.2 STANDARDS

1.2.1 The regulators furnished under this specification shall be designed, manufactured, and tested in accordance with ANSI Standard C57.15, latest revision thereof. That standard shall be a part of this specification.

1.3 RATINGS

1.3.1 All ratings shall be for 60 Hertz alternating current, oil-immersed, air-cooled voltage regulators capable of continuous operation at rated kVA without exceeding a 55°C average temperature rise above 40°C ambient at its rated current with a 10% raise or 10% lowering of tap positions, Type A regulators.

1.3.2 The basic impulse level (BIL) shall be 95kV. The nominal system voltage will be 12,470 GRN Y/7200 volts. Single-phase operation shall be at the nominal voltage of 7200 volts.

1.3.3 The BIL of the Bushings shall meet or exceed 95 KV.

1.3.4 Ambient temperature – minus 30°C to plus 50°C.

1.4 The voltage regulator voltage and capacity will be specified in the purchase order.

2 CONSTRUCTION

2.1 PRESSURE RELIEF DEVICE

2.1.1 All voltage regulators shall be designed with a mechanical, self-resetting pressure relief device releasing all excessive pressure build-ups without damage to the tank and venting between 4 PSIG and 10 PSIG.

2.1.2 All voltage regulators shall be equipped with a pressure relief device (Model 202-032-1 or District approved equivalent). Threads shall be sealed with pipe dope.

2.2 VOLTAGE REGULATOR OIL

2.2.1 Voltage regulators shall be insulated with new (unused) mineral oil. The oil shall meet the requirements of ANSI C57.12.00, Article 6.6.1 (1), ANSI C57.106 and ASTM 3487 Type II.

2.2.2 The voltage regulator nameplates shall indicate that the PCB content of said voltage regulator is less than 1 PPM or that at time of manufacture gas chromatographic analysis certified non-detectable PCB.

2.2.3 The oil shall be inhibited mineral oil containing 0.2% by weight DBPC.

2.2.4 The nameplate shall show the gallons of oil.

2.3 HIGH VOLTAGE BUSHINGS AND TERMINALS

2.3.1 Voltage regulators shall be equipped with identical and interchangeable bushing wells and corresponding load break inserts on the S and L bushings.

2.3.2 For regulators rated at 200 amps or less, the bushing wells shall be externally clamped, 200-amp rated, separable, and rated for primary switching per IEEE 386. The bushings shall conform to ANSI C57.12.25, Type II arrangement. Regulators larger than 200 amps shall have 600-amp bushings.

2.3.3 The load-break bushing inserts shall be Eaton-Cooper Power Systems LBI 215 or Elastimold (Catalog NO. 1601A4).

2.3.4 Inserts shall be shipped with physically wired down & secured dust caps or use a dust cap equipped with a pressure relief hole to prevent pressure build up in the dust cap that would cause loss of the dust cap.

2.3.5 The bushing designations (S, L, or SL) shall be permanently marked adjacent to the associated bushings.

2.3.6 All regulators shall be provided with a metal oxide varistor (MOV) bypass arrester connected across the series winding.

2.4 VOLTAGE REGULATOR TANKS

2.4.1 Voltage regulator tanks shall be of sealed tank design with welded steel construction.

2.4.2 There shall be a tap changer switch mounted on the front plate that can change the control and differential PT taps external to the unit.

2.4.3 Single phase voltage regulators rated 250 kVA and smaller must fit on a 66 x 88 inch vault lid with an opening of 48 x 20 inches.

2.4.4 There shall be gauges indicating oil temperature and oil level in a separate compartment with the controller (not in the HV compartment).

2.4.5 A 1" drain valve with sampling device and a 1" upper fill port with a brass or silicon bronze NPT style pipe plug.



Material Specifications

Date 9/21/2020

Rev. 0

Standard No.

Single-Phase Step Voltage Regulator – PAD

With a Communication-Ready Control Panel

1211.03

Page 5 of 13

2.5 GROUNDING PROVISIONS

- 2.5.1 Voltage regulators shall be furnished with a total of 2 grounding lugs with a grounding bus installed voltage regulator ground provision, centered at the bottom of the HV compartment and spaced horizontally 8 inches or more apart.
- 2.5.2 The ground lugs shall be Fargo (Catalog No. BVC-207-FT) with thin brass jam nut, installed in horizontal position on pad-mount voltage regulator.

2.6 TAP CHANGER

- 2.6.1 The tap changing mechanism shall be a motor driven, quick-break design and it shall be completely oil-immersed.
- 2.6.2 The tap changer shall be able to go from full buck to full boost in under 25 seconds.

2.7 PAINT FINISH

- 2.7.1 The external parts of the voltage regulator shall have a primer coat of special rust resisting paint. The primer coat shall be followed by two coats of finish paint. All paint applied shall be highly resistant to oil and weathering. The finish coat shall be semi-gloss and ANSI Green (Munsell 7GY 3.29/1.5) per C57.12.28.
- 2.7.2 All finishes shall be certified to meet or exceed the latest revisions of ANSI C57.12.28.
- 2.7.3 The top of the voltage regulator shall have at least 3.0 mils of paint. The voltage regulator sides and bottom shall have at least 3.0 mils of paint. Complete painting of the inside is acceptable.
- 2.7.4 One One-Quart Can of touch up paint used for the final coat shall be shipped with each regulator.

2.8 BYPASS SWITCH

- 2.8.1 The voltage regulator shall be equipped with a bypass switch module inside the cabinet and allows the regulator to be removed from service without interrupting the continuity of the system.
- 2.8.2 The bypass module shall provide hot-stick operable sectionalizing switches and have bushings matching the regulator.

2.9 COMPARTMENTAL LOCKING

- 2.9.1 All hinged or removable cabinet access lids or doors shall have a three-point latch and be provided with a 9/16" stainless steel or silicon bronze Pentahead captive bolt locking device and provisions for padlocking. The Pentahead bolt shall be coordinated so that it must be engaged before a padlock can be inserted into or removed from the hasp.
- 2.9.2 All regulators shall meet the requirements for tamper-resistance of NEMA TR-1 and Western Underground Guide No. 2.13.



Material Specifications

Date 9/21/2020

Rev. 0

Standard No.

Single-Phase Step Voltage Regulator – PAD
With a Communication-Ready Control Panel

1211.03

Page 6 of 13

2.10 NAMEPLATES


- 2.10.1 Each regulator shall be provided with two nameplates mechanically fastened; one mounted on the control enclosure and the other mounted on the regulator tank. Nameplates shall be made of stainless steel or laser etched anodized Aluminum and permanently marked with essential operating data as specified in the latest revision of ANSI C57.15.
- 2.10.2 The voltage regulator nameplate shall specifically state that the voltage regulator is mineral oil filled and the number of gallons of oil it contains. The nameplate shall also indicate that the PCB content of said voltage regulator is less than 1PPM or that the time of manufacture gas chromatographic analysis certified non-detectable PCB.
- 2.10.3 All nameplates shall have the manufacturer's serial number bar-coded into the nameplate. Manufacture identification characters shall not be included as part of the barcode. This barcode shall be etched into the nameplate. The character size shall be ¼ inch. The barcode shall be minimum of ½ inch high and 2-1/2 inches wide.
- 2.10.4 The District also requests the following information be provided on similar nameplates located on both the control panel and tank.
- Impedance at the 16 raise position and rated kVA
 - Diagrammatic sketch of the windings
 - Untanking weight
 - Weight of tank and fittings
 - Weight and gallons of oil in use
 - Total weight
 - District purchase order numbers
- 2.10.5 There shall be a permanently stenciled note on the regulator stating that the regulator must be on neutral before operating the bypass switch.

3 RIV REQUIREMENT

- 3.1 The radio influence voltage shall not exceed 100 microvolts (average measurement) at 1000 kHz measured at 115 percent of rated voltage in accordance with NEMA Specification TR-1.

4 REGULATOR CONTROLS

- 4.1 The District approved regulator control panel is the latest version of the Eaton's Cooper Power series CL-7. The following setting and/or options shall be provided.

	<i>Material Specifications</i>	<i>Date 9/21/2020</i>	<i>Rev. 0</i>	<i>Standard No.</i>
	Single-Phase Step Voltage Regulator – PAD			1211.03
	With a Communication-Ready Control Panel			<i>Page 7 of 13</i>

4.2 REVERSE POWER FLOW OPERATION

4.2.1 All voltage regulators shall be provided with reverse power flow detectors properly assembled on the unit. The reverse power flow detector shall be capable of detecting power flow in the reverse direction and insuring that the automatic voltage control of the regulator is sensing what is effectively the load or output voltage of the unit. A (source-to-load) differential potential transformer (PT) shall be supplied as part of this voltage regulator accessory. The addition of the PT shall also permit metering for reverse power flow conditions. The PT shall be located internally to the regulator tank.

4.3 TAP POSITION INDICATOR

4.3.1 An external position indicator shall indicate the tap changer position. There shall be a tap position reset button on the controller.

4.4 LIMITED OPERATING RANGE CAPABILITY

4.4.1 All voltage regulators shall include a feature that will permit additional current carrying capabilities at reduced regulation according to the following schedule:

Regulation (Percent)	CURRENT (% of 55°C Rating)
± 10	100
± 8.75	110
± 7.5	120
± 6.25	135
± 5	160

4.4.2 The adjustment for the load bonus device shall be located inside the faceplate of the tap position indicator to prevent inadvertent adjustment.

4.5 CONTROL PANEL

4.5.1 The regulator control panel shall be mounted in a weather resistant enclosure inside the accessory compartment.

4.5.2 The control panel shall be hinge-mounted and designed for easy replacement. The front panel shall be constructed to provide direct control interchangeability without requiring the removal of the control enclosure. Visible means shall be provided to de-energize the control and short the current transformer prior to testing or removal of the control.


4.5.3 All leads in the control shall be either color coated or labeled for easy identification.

4.5.4 All printed circuit boards shall be conformal coated for fungi and moisture protection.

- 4.5.5 A ratio correction transformer shall be provided inside the control enclosure to provide easy access to fine voltage adjustment. Ratio correction taps and corresponding system voltage shall be clearly identified on the regulator nameplates.
- 4.5.6 The regulator control panel shall be microprocessor based with an event recorder that has the ability to time stamp all events placed in the event recorder. The control panel shall have the ability to digitally meter with Class 1 accuracy, as defined in the latest revision of ANSI C57.15.
- 4.5.7 The control panel shall have USB update and download capabilities and be compatible with Cooper Proview NXG software.
- 4.5.8 The control panel shall operate properly over a temperature range of minus 40°C to plus 85°C.
- 4.5.9 A heater in the control panel box shall be provided to mitigate moisture concerns in the controller box.
- 4.5.10 The control panel shall have a digital communication port(s) located on the front panel. The port(s) shall allow trouble-free communications between a laptop (or personal computer or Data Reader) and the control panel. The successful Bidder at no additional cost to the District shall supply all accessories and software for trouble-free communications.
- 4.5.11 Fiber-Optic Communication for Remote Access utilizing the DNP 3.0 protocol.
- 4.5.12 Retaining springs to secure manuals to the cabinet shall be supplied on the inside of the enclosure. Storage of the manuals, in this manner, shall not adversely affect the control unit.
- 4.5.13 The control panel shall allow automatic operation of the voltage regulator under reverse power flow conditions. The reverse power flow detector shall operate within the following limits: Sensitivity – reverse power flow detected at two percent (2%) of the rated 55°C load current of the regulator.
- 4.5.14 Load power factor – 0.5 lag to 0.55 lead.
- 4.5.15 Input Voltage – 100 to 140 volts, 60 Hertz. Potential transformer shall be internally located for input voltage requirements.
- 4.5.16 The motor starting capacitor shall be located inside the Control panel and be easily accessible for maintenance.

5 TESTS

- 5.1 Each voltage regulator shall receive complete tests at the factory in accordance with latest ANSI C57.15 and NEMA TR.1.

 <p>CHELAN COUNTY DISTRIBUTION</p>	<i>Material Specifications</i>	<i>Date 9/21/2020</i>	<i>Rev. 0</i>	<i>Standard No.</i>
	Single-Phase Step Voltage Regulator – PAD			1211.03
	With a Communication-Ready Control Panel			<i>Page 9 of 13</i>

5.2 In addition, every voltage regulator shall be test operated for a minimum of 250 operations, stepping through multiple steps in both the raise and lower directions to verify correct control and tap changer operation.

5.3 Copies of Certified test reports shall be available for District inspection at the District's request. Test reports shall be sent to District prior to shipping regulators.

5.4 **SHORT CIRCUIT WITHSTAND**

5.4.1 All voltage regulators shall be capable of withstanding, without damage, short circuit currents as specified in the latest revision of ANSI C57.15.

6 **EVALUATION**

6.1 Appendix A of this specification must be completely filled out for bid/quote to be evaluated. Prices will be firm for delivery date specified. Failure to include prices and/or delivery in the appropriate blank for each item will be sufficient cause for rejection of bid.

6.2 For bid evaluation, regulator losses will be considered. The evaluation price will be calculated using the following equation:

$$REP = BP + (NL \times \$4.07) + (LL \times \$1.79)$$

REP - Regulator Evaluation Price

BP - Base Bid Price

NL* - Core Loss (Watts)

LL* - Conductor Loss (Watts)

* For loss evaluation purposes, loss values at 16 raise in the Bidder's Data shall be used.

7 **CONTROL INTERROGATION SOFTWARE**

7.1 Software required to interrogate, modify, and download control panel functions, and event recorder shall be compatible with Microsoft Windows operating systems.

7.2 Included with the software shall be a site license that would allow for the software to be installed on any personal computer and server that Chelan PUD deems necessary.

8 DEVIATION FROM SPECIFICATION

8.1 It is expected that any regulators supplied by the vendor will be in strict accordance with this specification unless appropriately noted with the original bid. The purchaser reserves the right to evaluate any exceptions that are taken by a vendor. Any deviation from this specification without prior approval will be sufficient cause for rejection of the regulators furnished and/or rejection of that manufacturer from furnishing the equipment in the future. All deviations shall be noted on the Appendix B form "Deviations From Specifications".

9 SHIPPING INSTRUCTIONS

9.1 Voltage regulators shall be shipped completely assembled and oil filled with the proper amount of voltage regulator oil.

9.2 Voltage regulators shall be shipped on individual pallets (one voltage regulator per pallet). Voltage regulators shall be securely attached to the pallets to allow for forklift handling.

9.3 Voltage regulators shall be shipped on an enclosed van.

9.4 Voltage regulators must be shipped FOB Destination.

10 APPENDIX A – EQUIPMENT DATA SHEET

Line Item Number:	Delivery Date:
Description:	
Manufacture:	
Model:	
Control Cabinet Manufacture & Model Number:	
Temperature Rating	°C
Size	kVA
Voltage Rating	kV
Ampere Rating	AMP
Design Working Pressure at Tank	PSI
Total Weight:	Lbs.
Untanking Weight:	Lbs.
Oil Weight:	Lbs.
Case & Fittings Weight:	Lbs.
Shipping Weight:	Lbs.
Maximum Megger voltage that can be applied to Series winding	kV
Maximum Megger Voltage that can be applied to Shunt winding	kV
Volume of Oil:	Gal
Maximum ampacity of switch assembly	Amps
Maximum ampacity of contacts	Amps
Height	Inches
Width	Inches
Depth	Inches
Core loss at 16 raise at full load, rated current	Watts
Conductor losses at 16 raise at full load, rated current:	Watts
Manufacture of pressure relief device	
Model number of pressure relief device	
Percent Z*	
Series winding wire material	
Shunt winding wire material	
Type of core material	
Recommended number of tap changer operations per contact prior to inspection.	
Lifetime number of tap changer operations per contact.	
Lifetime number of total tap changer operations per contact at full load current and 0.8 power factor.	

