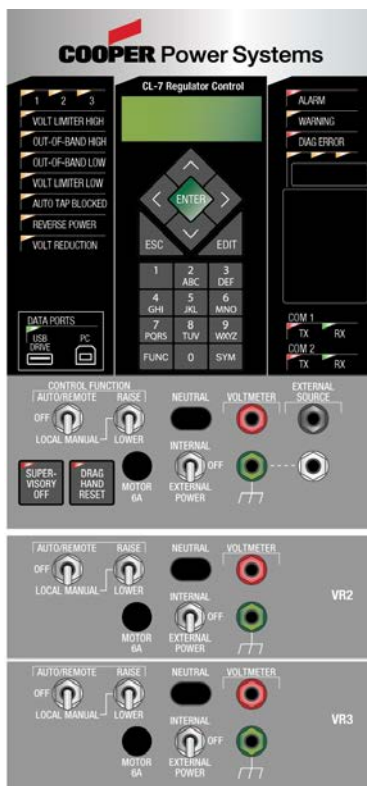


# Single-Phase Step Voltage Regulator

- Overhead Mounted -

With a Communication-Ready Control Panel



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## 1 GENERAL

- 1.1 This specification covers electrical, mechanical and safety features and characteristics of outdoor, single phase, oil immersed, 60 Hz, 65°C temperature rise by resistance, self cooled and force-air cooled step-type voltage regulators. The voltage regulators must be completely self-contained and provide +/- 10% voltage regulation in thirty-two (32) steps of 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 - 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 - 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 it's rated current with a 10% raise or 10% lowering of tap positions. The basic impulse level (BIL) shall be 95 kV. The nominal system voltage will be 12,470 GRD Y/ 7200 volts. Single-phase operation shall be at a nominal voltage of 7200 volts.
- 1.4 The voltage regulators shall have the following capacities:

<b>kVA RATING</b>	<b>AMPERE RATING*</b>
38	50/56
76.2	100/112
114.3	150/168
167	219/245
250	328/367
333	438/490

\*The first value shall be the 55°C rating. The value to the right of the slash shall be the ampere rating at 65°C.

## 2 CONSTRUCTION

### 2.1 PRESSURE RELIEF DEVICE

- 2.1.1 All voltage regulators shall be designed such that all excessive pressure build-ups are released without damage to the tank or the release of excessive amounts of oil.
- 2.1.2 All voltage regulators shall be equipped with a mechanical, self-resetting pressure relief device, venting between 4 PSIG and 10 PSIG.



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## 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 11.
- 2.2.2 The voltage regulator nameplate 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 percent 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 three identical and interchangeable, cover-mounted, wet process porcelain high voltage bushings with clamp type terminals in accordance with ANSI C57.15, latest revision. The BIL of the Bushings shall meet or exceed 95 kV. The bushings shall be light gray in color and the minimum creep shall be 16 inches. The bushings shall have the following clamp-type terminals:

VOLTAGE REGULATOR SIZE	CLAMP TERMINAL SIZE RANGE
150 AMP AND BELOW	#6 TO 250 KCMIL
ABOVE 150 AMP AND BELOW 300 AMP	#6 TO 500 KCMIL
ABOVE 300 AMP	#6 TO 800 KCMIL

- 2.3.2 All clamp terminals shall be marked according to the latest revision of ANSI C57.15.
- 2.3.3 The clamp type terminal shall be capable of being tightened with a 9/16 inch Fargo wrench (Fargo Manufacturing, Catalog No. GP-203).
- 2.3.4 The bushing designations (S, L, or SL) shall be permanently marked on the regulator cover adjacent to the associated bushings.
- 2.3.5 All regulators shall be provided with a metal oxide varistor (MOV) bypass arrester connected across the series winding.
- 2.3.6 All regulators shall be provided with polymer housed lightning arresters, riser pole, 9kV, 7.65 MCOV, with isolator and wildlife protector, connected to the source, and load bushings. Cooper URS0905-0A1A-1A1A or equivalent. Arresters shall be mounted on removable brackets.
- 2.3.7 The physical arrangement of the high-voltage terminations shall per Figure #3 of ANSI Standard C57.15.
- 2.3.8 Wildlife Protector - A factory provided wildlife protector shall be included on the high voltage bushings and series arrester.



## 2.4 VOLTAGE REGULATOR TANKS

- 2.4.1 Voltage regulator tanks shall be of sealed tank design with welded steel construction.
- 2.4.2 The overall size of the voltage regulators and the weight of the voltage regulators, once filled with oil, shall not exceed the following:

SIZE (AMP)	WEIGHT (LBS)	HEIGHT* (INCHES)	WIDTH** (INCHES)	DEPTH*** (INCHES)
50	1500	65	35	35
100	2000	70	35	35
150	2000	75	40	42
219	2500	75	40	45
328	3000	85	40	55
438	3600	100	44	61
*Height shall be measured from bottom of tank to top of primary terminal at top of primary bushing or arrester (if arrester is higher than terminal).				
**Width shall be measured from hanger bracket to lifting hook or cooling fin at farthest point from hanger bracket.				
* * *Depth shall be measured from cooling fin to outside of control box if it were mounted on tank.				

- 2.4.3 All tanks shall be furnished with an external oil sight gauge, which indicates both oil level and oil color.
- 2.4.4 Voltage regulators rated 150 amperes and below shall be pole-mounted and provided with welded-on hanger brackets. Voltage regulators rated 219 amperes and above shall be provided with a base suitable for securing them to a pad or elevating structure. All voltage regulators must be capable of being secured to an elevating structure.
- 2.4.5 All tanks shall be furnished with either handholds in the lid or with an externally mounted and accessible terminal block to allow easy access to potential transformer connections. The covers to these items shall be gasketed and removable.
- 2.4.6 All regulators shall be designed so that they can be partially or completely untanked for inspection and maintenance without disconnecting any internal electrical or mechanical connections. After the unit is untanked, it shall be possible to operate the regulator mechanism and to test the control panel from an external 120 VAC source without any reconnections between the control and the regulator.
- 2.4.7 Tanks shall come equipped with all accessories prescribed in the latest revision of ANSI C57.15 in addition to those described in these specifications.

## 2.5 GROUNDING PROVISIONS

Voltage regulators shall be furnished with ground provisions as specified in the latest revision of ANSI C57.15. Grounding provisions shall be 300 series stainless steel. The grounding provisions shall be tapped with 1/2"-13 NC holes that shall have a minimum thread depth of 0.5 inches. Each grounding provision shall be welded to the lower portion of the tank of the voltage



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regulator in such a manner as to protect the integrity of the threaded holes. Threads shall NOT be painted and shall be protected with a plug during shipping.

## 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 ANSI Standard No. 70 sky gray color.

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 lid shall have at least 3.0 mils of paint. The voltage regulator sides and bottom shall have at least 3.0 mils of paint. The inside of the voltage regulator shall have at least 3.0 mils of paint from a point 2 inches below the oil level up to and including the inside of the top cover. Complete painting of the inside is acceptable.

2.7.4 Two One – Quart Cans of paint used for the final coat shall be shipped with each line item.

## 2.8 NAMEPLATES

2.8.1 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 AL and permanently marked with essential operating data as specified in the latest revision of ANSI C57.15.

2.8.2 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 1 PPM or that at the time of manufacture gas chromatographic analysis certified non-detectable PCB.

2.8.3 All nameplates shall have the manufacturer's serial number bar-coded into the nameplate. Manufacturer 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 a minimum of 1/2 inch high and 2-1/2 inches wide.

2.8.4 The District also desires 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
- Diagram-matic sketch of the windings
- Ratio correction transformer taps and corresponding system voltages
- Untanking weight



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- Weight of tank and fittings
- Weight of oil in use
- District purchase order numbers

### **3 RIV REQUIREMENT**

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**

The District approved regulator control panel is the latest version of the Cooper CL-6A. The following settings and/or options shall be provided.

#### **4.1 REVERSE POWER FLOW OPERATION**

All voltage regulators shall be provided with reverse power flow detectors properly assemble 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. If required 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.

#### **4.2 TAP POSITION INDICATOR**

An external position indicator shall indicate the tap changer position. The position indicator shall be mounted above the oil level and shall be slanted downward to enable easy reading from below, when the regulator is pole mounted.

#### **4.3 LOAD BONUS CAPABILITY**

4.3.1 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 <sup>0</sup> C Rating)
+/- 10	100
+/- 8.75	110
+/- 7.5	120
+25	135
+/- 5	160

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



#### 4.4 CONTROL PANEL

- 4.4.1 The regulator control panel shall be mounted in a weather-resistant enclosure, which is capable of being padlocked. The control enclosure shall have an external grounding provisions that shall be 300 series stainless steel. The grounding provisions shall be tapped with 1/2"-13 NC holes that shall have a minimum thread depth of 0.5 inches. Each grounding provision shall be welded to the control enclosure in such a manner as to protect the integrity of the threaded holes. Threads shall NOT be painted and shall be protected with a plug during shipping.
- 4.4.2 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.
- 4.4.3 All leads in the control shall be either color coated or labeled for easy identification.
- 4.4.4 All printed circuit boards shall be conformal coated for fungi and moisture protection.
- 4.4.5 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. A software provision to provide this feature in the control will also be accepted.
- 4.4.6 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.
- 4.4.7 The control panel shall have USB update and download capabilities and be compatible with the Cooper Proview NXG software.
- 4.4.8 The control panel shall operate properly over a temperature range of minus 40°C to plus 85°C.
- 4.4.9 A thermostatically controlled heater assembly to reduce moisture shall be provided. The Heater shall be equipped with an "ON-OFF" switch. In the "ON" position the thermostat in the heater shall activate the heater at approximately 85°F and turn the heater "OFF" at approximately 100°F.
- 4.4.10 The controls shall include remote mounting cable to allow the remote placement of the regulator controls. The cable shall be 45 feet in length and shall be pre-connected at the factory. The bottom 10 feet of cable shall be armored.
- 4.4.11 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.
- 4.4.12 Fiber-Optic Communication for Remote Access utilizing the DNP 3.0 protocol.



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- 4.4.13 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.
- 4.4.14 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.
- 4.4.15 Load power factor - 0.5 lag to 0.55 lead.
- 4.4.16 Input Voltage - 100 to 140 volts, 60 Hertz. Potential transformer shall be internally located for input voltage requirements.
- 4.4.17 Ambient Temperature - minus 30°C to plus 50°C.
- 4.4.18 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.
- 5.2 In addition, every voltage regulator be 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 and to assure that all infant failures are detected at the factory.
- 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 the regulators.
- 5.4 At the option of the District, voltage regulators may be tested for acceptance upon receipt.
- 5.5 SHORT CIRCUIT WITHSTAND - All voltage regulators shall be capable of withstanding, without damage, short circuit currents as specified in the latest revision of ANSI C57.15.



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## 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:

$$\text{REP} = \text{BP} + (\text{NL}) (\$4.07) + \text{LL} (\$1.79)$$

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 capable with Microsoft Windows XP & 7 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 note on the Appendix B form "Deviations From Specifications"

## 9 SHIPPING INSTRUCTIONS

9.1 Voltage regulators shall be shipped completely assembled in an enclosed van and 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 shipped on a flatbed truck or having damaged or broken securing devices shall be cause to reject delivery.



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**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
AMP		
Manufacture of pressure relief device		
Model number of pressure relief device		
Percent Z*		
Design Working Pressure at Tank		PSI
Total Weight:		Lbs.
Untanking Weight:		Lbs.
Oil Weight:		Lbs.
Case & Fittings Weight:		Lbs.
Shipping Weight:		Lbs.
Number of turns in series winding		
Number of turns in shunt winding		
Series winding wire material		
Shunt winding wire material		
Type of core material		
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
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.		
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



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