Substation Design Instruction

Cooper Power Systems
voltage regulator VR-32

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SDI 220 - Cooper Power Systems voltage regulator VR-32

Contents

1.0  PURPOSE ........................................................................................................... 3
2.0  SCOPE ................................................................................................................ 3
3.0  REFERENCES .................................................................................................... 3
4.0  DEFINITIONS AND ABBREVIATIONS ............................................................... 4
5.0  ACTIONS ............................................................................................................ 4
5.1  General ............................................................................................................... 4
   5.1.1  Introduction ................................................................................................... 4
   5.1.2  Product approval number and stock code ..................................................... 4
   5.1.3  Ratings ......................................................................................................... 5
   5.1.4  Features ....................................................................................................... 5
   5.1.5  Dimensions and weight .............................................................................. 7
5.2  Installation .......................................................................................................... 7
   5.2.1  General ......................................................................................................... 7
   5.2.2  Regulator controller ...................................................................................... 7
      5.2.2.1  Regulator controller CL7 ...................................................................... 7
5.3  Operating diagrams ............................................................................................ 8
   5.3.1  Three (3) single phase regulators in closed delta formation .......................... 8
   5.3.2  One (1) single phase regulator on single phase line (11kV ph – ph) ............... 9
6.0  AUTHORITIES AND RESPONSIBILITIES .......................................................... 9
7.0  DOCUMENT CONTROL ..................................................................................... 9
1.0 PURPOSE

To provide technical and reference information to assist with the safe design, installation, commissioning, operation and decommissioning of the single phase voltage regulators VR-32, manufactured and supplied by Cooper Power Systems.

2.0 SCOPE

The scope of this document provides reference to the various lifecycle stages of the switchgear and therefore should be read in conjunction with:

- Mounting and construction requirements: MCI 0005
- Earthing design, construction and testing: EDI 100
- Specification for new equipment: ETS 0078
- General details and minimum design requirements: SDI 101 and MDI 0031
- Testing and commissioning: SDI 120 and GNV 1044
- Ongoing maintenance requirements: SMI 110
- Standard drawing requirements: SAD 0001
- Environmental: EMS 0001
- Disposal: GSU 0012

This instruction should be read in conjunction with the following documents from Cooper Power Systems:
- 255-10-10
- 225-11-1
- 225-11-2
- 225-70-1
- 225-70-5

3.0 REFERENCES

- Company Policy 9.2.2 - Network Protection
- Company Policy 9.2.5 - Network Asset Design
- Company Policy 9.7.1 - Network Asset Constructions
- Company Policy 9.8.3 - Network Operations
- Company Policy 9.8.3 - Network Asset Maintenance
- Company Policy 9.2.10 - Network Asset Ratings
- Company Procedure GSU 0012 – Selection and approval of a disposal method
- Division Procedure GNV 1044 - Commissioning Network Electrical Assets
- Environmental Management Standard EMS 0001 – Environmental impact assessment and environmental management plans
- Earthing Design Instruction EDI 100 – Distribution earthing design, construction and test
- Equipment Technical Specification ETS 0078 - 11kV distribution voltage regulator
- Mains Construction Instruction MCI 0005 – Overhead distribution construction standards manual
- Mains Design Construction MDI 0031 – Overhead distribution: Designs standards manual
- Standard Asset Data SDA 0001 – Project drawing standards
- Substation Design Instruction SDI 120 – Testing and commissioning for distribution systems
4.0 DEFINITIONS AND ABBREVIATIONS

ANSI American National Standards Institute
VR voltage regulator transformer
RTU remote terminal unit
SCADA Supervisory Control and Data Acquisition
UV ultra violet

For further definitions, refer to AS 1852.

5.0 ACTIONS

5.1 General

5.1.1 Introduction

Cooper Power Systems voltage regulator VR-32 is a single-phase device.

A voltage regulator can also be described as an autotransformer.

Regulators are used on distribution lines where voltage drop is reported to be beyond acceptable limits. They can regulate the load side voltage on distribution lines from 10% raise (boost) to 10% lower (buck) in 32 steps of 0.625% each. This can help maintain the quality of voltage supplied to customers.

The regulators can be used on single-phase 11kV lines (11kV phase-to-phase).

5.1.2 Product approval number and stock code

Cooper regulators supplied under contract no. 996/08T (2008 onwards) consist of stainless steel tanks. Some of the regulators purchased prior to 2008 consist of ordinary steel tanks. All regulators with ordinary steel tanks installed in coastal areas need to be replaced with
stainless steel tank regulators. When a steel tank regulator is removed from a coastal site it should not be reused in a coastal site. The steel tank regulators shall only be used in installations greater than five (5) km away from the coastline.

The following voltage regulators supplied by Cooper Power Systems have been approved for use in Endeavour Energy’s 11kV network as shown in Table 1. These voltage regulators are manufactured in the United States of America. Effective 2013, Cooper Power Systems has been acquired by Eaton Corporation.

**Table 1: Approved voltage regulators**

<table>
<thead>
<tr>
<th>Endeavour Energy Stock code</th>
<th>Cooper’s part number</th>
<th>Description</th>
<th>Approval no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1555465</td>
<td>WED05B78RYQJ</td>
<td>11kV 52A, 58kVA Single voltage Regulators Type VR 32 with stainless steel tank</td>
<td>O10026B</td>
</tr>
<tr>
<td>1555473</td>
<td>WED11B78RYQJ</td>
<td>11kV 104A, 114kVA Single voltage Regulators Type VR 32 with stainless steel tank</td>
<td>O10023B</td>
</tr>
<tr>
<td>1555481</td>
<td>WED16B78RYQJ</td>
<td>11kV 150A, 165kVA Single voltage Regulators Type VR 32 with stainless steel tank</td>
<td>O10024B</td>
</tr>
<tr>
<td>1555499</td>
<td>WED22B78RYQJ</td>
<td>11kV 200A, 220kVA Single voltage Regulators Type VR 32 with stainless steel tank</td>
<td>O10025B</td>
</tr>
</tbody>
</table>

**5.1.3 Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage regulator</td>
<td>VR 32</td>
</tr>
<tr>
<td>Regulator controller</td>
<td>CL6A*</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>11kV</td>
</tr>
<tr>
<td>Highest voltage</td>
<td>12kV</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Basic Impulse level</td>
<td>95kV</td>
</tr>
<tr>
<td>Cooling</td>
<td>ONAN</td>
</tr>
<tr>
<td>Load current</td>
<td>52A, 104A, 150A and 200A</td>
</tr>
</tbody>
</table>

* Voltage regulator controller CL6A* is the latest version and will be supplied by Cooper’s for all new regulators. However, there are a number of installations in Endeavour Energy’s network where an earlier version of the controller CL5E was supplied and installed.

For these units, refer to Cooper’s document S225-10-10.

**5.1.4 Features**

The standard features of Cooper’s voltage regulators are:

- Dual rated for 55/65 deg. C rise in the winding temperature (however, 55 deg. C rating is to be used in the network).
- Unit construction (single phase).
- Sealed tank construction.
- Pressure relief device.
- Clamp connectors.
- MOV - external series arrester.
- Oil sight gauge.
- Drain valve and oil sampling device.
- Regulators controller CL6A.
- **120V** single phase 50Hz power supply from an inbuilt potential transformer on the load side (only in the units supplied under tender no.996/08T).

![Cooper VR32 voltage regulator diagram](image)

**Fig. 1:** Cooper VR32 voltage regulator
5.1.5 **Dimensions and weight**

<table>
<thead>
<tr>
<th>VR 32 single phase</th>
<th>52A</th>
<th>104A</th>
<th>150A</th>
<th>200A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width, mm</td>
<td>610</td>
<td>762</td>
<td>864</td>
<td>1015</td>
</tr>
<tr>
<td>Length, mm</td>
<td>889</td>
<td>1154</td>
<td>1364</td>
<td>1320</td>
</tr>
<tr>
<td>Height, mm</td>
<td>1893</td>
<td>1994</td>
<td>2042</td>
<td>2073</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>586</td>
<td>814</td>
<td>1041</td>
<td>1211</td>
</tr>
</tbody>
</table>

5.2 **Installation**

5.2.1 **General**

The voltage regulator shall be installed in accordance with MCI 0005 - Overhead distribution construction standards manual and Drawing no. 275182. Earthing of the voltage regulator shall be performed in accordance with EDI 100 - Distribution earthing design, construction and test, and commissioning performed in accordance with SDI 120 - Testing and commissioning for distribution systems.

Installation should be performed safely with all relevant authorisations, training, safe work method statements and all relevant Safe Work and WorkCover codes of practice.

5.2.2 **Regulator controller**

The regulator controller is CL6A and provides the following control functions:

- Self-powered (without the need for an external auxiliary supply).
- Auto-off - manual selector switch.
- Automatic electronic voltage regulation apparatus with line drop compensator functionality.
- Clear indication when regulator is on neutral tap.
- Tap position indicator.
- A six-digit operations counter, that counts every tap change.
- Raise and lower control switch at the regulator. Each switching operation initiates only one tap-change. The switch must be turned to the off-position and the tap-change completed before initiating a new tap-changing operation.
- Manual handle for emergency and maintenance operation.
- A thermostatically controlled space heater.

The regulator controller CL6A is fitted with a data communication port RS232. If required, the data communication port can be used to transmit the following information/control functions to Endeavour Energy’s SCADA control facility using a radio/modem:

- Current (A)
- Voltage (V)
- Active power (W)
- Power direction (import or export)
- Local/supervisory switch position
- Tap position raise/lower control
- Tap position indication
- Tap in neutral position

5.2.2.1 **Regulator controller CL7**

Beginning 2015, Cooper will be supplying the CL 7 controller. The CL7 has a single phase and a multi-phase option. The new CL7 can be retrofitted to the existing voltage regulators. (Refer to Cooper’s document no.: S225-70-5 for retrofit instructions)
The additional features are as follows:

- Real time updates
- Improved control of voltage management
- Scalable communications
- Maintenance alarms
- Tap position tracking mode
- USB port for programming
- New Proview software

Refer to Cooper’s document no.: S225-70-1 for further information.

5.3 Operating diagrams

5.3.1 Three (3) single phase regulators in closed delta formation

Symbol for system diagram

Insert ‘SC’ for SCADA controlled VR
5.3.2 One (1) single phase regulator on single phase line (11kV ph – ph)

Note: For the sake of clarity, lightning arresters have been omitted. Refer to the Cooper’s manual

6.0 AUTHORITIES AND RESPONSIBILITIES

The **Chief Engineer** has the authority and responsibility for approving this instruction and approving variations to the requirements of this instruction.

The **Manager Primary Systems** has the authority and responsibility for endorsing and recommending changes and revisions to this instruction.

The **Network Substations Manager** has the authority and responsibility for revising and updating this instruction in accordance with Company Policy and Procedures.

**Regional Managers** has the authority and responsibility for determining all designs carried out by Regional employees conform to the requirements of this instruction.

The **Manager Network Connections** has the authority and responsibility for determining all designs carried out by Level 3 ASPs conform to the requirements of this instruction.

It will be the ASP’s responsibility to establish the latest issue of any instruction or drawing relevant to or listed in this manual is available and used during the design of any project.

7.0 DOCUMENT CONTROL

**Documentation content coordinator:** Network Substations Manager

**Documentation process coordinator:** Standards Process Coordinator