

Saudi Electricity Company



الشركة السعودية للكهرباء

SEC DISTRIBUTION MATERIALS SPECIFICATION

43-SDMS-02

DATE: 16-03-2005G

43-SDMS-02

SPECIFICATIONS

FOR

**MV STEP VOLTAGE REGULATORS
UP TO 36 KV**

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1.0 SCOPE

This SEC Distribution Materials Specification (SDMS) specifies the minimum technical requirements for design, engineering, manufacture, inspection, testing and performance requirements of outdoor Step Voltage Regulators, intended to be used in the MV overhead distribution system of Saudi Electricity Company (SEC) in Saudi Arabia.

2.0 CROSS REFERENCES

This material standard specification shall be read in conjunction with SEC Specification No.01-SDMS-01 latest revision for 'General Requirement for all Equipments/Materials', which shall be considered as an integral part of this SDMS. This SDMS shall also be read in conjunction with SEC Purchase order requirements.

3.0 APPLICABLE CODES & STANDARDS

The latest revision/amendment of the following codes and standards shall be applicable for the equipment/material covered in this SDMS. In case of conflict, the vendor/manufacture may propose equipment/material conforming to one group of industry codes and standards quoted hereunder without jeopardizing the requirements of this SDMS.

- | | | |
|-----|-----------------|---|
| 3.1 | IEC 60437 | Radio Interference Test On High-Voltage Insulation. |
| 3.2 | IEC 60551 | Determination Of Transformer And Reactor Sound Level. |
| 3.3 | IEEE Std C57.15 | IEEE Standard Requirements, Terminology, and Test Code for Step-Voltage Regulators. |
| 3.4 | BS-729 | Hot Dip Galvanized Coatings on Iron and Steel Articles. |
| 3.5 | ANSI C57.95 | Guide for loading liquid-immersed step-voltage and induction voltage regulators. |
| 3.6 | ASTM D-202 | Winding Insulation Requirements. |



4.0 DESIGN & CONSTRUCTION REQUIREMENTS

4.1 Design Criteria

4.1.1 The Step Voltage Regulators shall be single phase units operating in closed or open delta configuration. They shall be suitable for outdoor use and shall be naturally cooled.

4.1.2 The Step Voltage Regulator shall be capable of carrying overloads indicated in ANSI C57-95. The tender shall include test certificates indicating that these requirements are met.

4.2 Ratings

| Ref | Description | Unit | Specified values | |
|-----|--|--------------|----------------------------------|----------------------------------|
| | | | 13.8kV (system) | 33kV (system) |
| 1 | Rated Input Voltage | kV | 13.8kV \pm 15% | 33kV \pm 15% |
| 2 | Rated Output Voltage | kV | 13.8kV | 33kV |
| 3 | Regulator Current Rating | Amps | 100, 150, 200, 300, 400 | 100, 150, 200 |
| 4 | Creepage Distance for bushings: - For coastal & high altitudes - For dry areas | mm | 552 | 1320 |
| | | mm | 345 | 825 |
| 5 | BIL | kV | 95, 110 | 170, 200 |
| 6 | Impedance Voltage | percent | 0.5 % of rated voltage (maximum) | 0.5 % of rated voltage (maximum) |
| 7 | Radio Influence Voltage | μ v | 250 | 650 |
| 8 | Type of Cooling | - | ONAN | ONAN |
| 9 | Average Winding Temperature Rise Limit | $^{\circ}$ C | 55 | 55 |
| 10 | Top Oil Temperature Rise Limit | $^{\circ}$ C | 50 | 50 |
| 11 | Maximum Hot Spot Temperature | $^{\circ}$ C | 95 | 95 |



- 4.2.1 The Step Voltage Regulator shall be suitable for a nominal system voltage of 13.8 kV/ 33 kV $\pm 15\%$ as requested and shall be supplied with Load Tap Changers, ± 16 steps in $\frac{1}{8}\%$ increments.
- 4.2.2 The tap changing mechanism shall be motor driven, quick-drive type in a 3-phase system configuration and shall operate in tandem by its voltage control units.
- 4.2.3 Step Voltage Regulators shall be designed and constructed to withstand the mechanical and thermal stress without damage, produced by the external short circuits of 25 times the base rms symmetrical current. The maximum peak of the short circuit current that the regulator is required to withstand is equal to 2.26 times the required rms symmetrical short circuit current. The short circuit shall be for a duration of 2s to determine the thermal stresses.
- 4.2.4 Step Voltage Regulator shall be suitable for use with insulating oil as per SEC-02-01, and shall be supplied with initial filling.
- 4.2.5 It shall be possible to supplement throughout the current rating of the Voltage Regulator by limiting the range of voltage regulation, as per the values shown in the following table:

| Range of Voltage Regulation (percent) | Current rating (percent) |
|--|-----------------------------|
| ± 10 | 100 |
| ± 8.75 | 110 |
| ± 7.50 | 120 |
| ± 6.25 | 135 |
| ± 5.00 | 160 |

4.3 Bushings

The Voltage Regulator shall be fitted with Porcelain or Polymer bushings conforming to latest relevant International Standards and compatible with SEC Service Conditions and System Parameters. The bushings shall be provided with anti-bird device. The bushings shall be terminated by flat pad terminals to accept vertical connection with ACSR conductor size 70 sq.mm to 170 sq.mm.



4.4 Lighting Arresters

Each single phase voltage regulator unit shall be fitted with a bypass arrester connected across the series winding between the source and load bushings.

Each single phase voltage regulator unit shall be provided with mounting arrangements to install three shunt surge arresters.

4.5 Grounding

The Voltage Regulator shall be provided with a copper solderless bolted connector for tank grounding which will accommodate conductor up to 70 sq. mm.

4.6 Oil Preservation & Regulator Tank

4.6.1 Regulator shall be of the sealed tank type and the top cover shall be bolted to the main tank.

4.6.2 The Regulator shall have provision for venting gases, built up due to tap changing under oil in energized condition.

4.6.3 The Regulator shall be designed such that partial or complete un-tanking for inspection and maintenance may be taken up without disconnecting any internal electrical or mechanical connections.

4.7 Tank

4.7.1 The tank shall be preferably made of stainless steel sheet of minimum thickness 3mm. The tank and its accessories shall be adequately protected against corrosion and the supplier shall include a statement of protection proposed. Hot dip galvanizing is preferred (in case tank is not stainless steel fabricated), otherwise large size tanks shall be sand blasted and then immediately zinc sprayed to an average weight deposit in accordance with BS-729. This shall be followed by zinc or zinc chromate based primary paint and two coats of durable oil and weather resisting paint shall be applied. The color of each coat shall be easily distinguishable. The final coat shall be epoxy based. Finish color shall be cement gray RAL-7033, as per DIN. Zinc spray shall be in accordance with ISO-2063. The inside of tank shall be oil resistant to avoid oil contamination. The tank shall be preferably sealed and dielectric fluid tight, and suitable to operate under all operating conditions.



4.7.2 All bolts, studs, nuts and washers shall be plated to BS-3382 and shall have corrosion proof locking features and shall confirm to BS-3692.

4.8 Controls

4.8.1 Each single phase unit of Voltage Regulator shall have one control unit in a weather resistant enclosure with provision for locking.

4.8.2 The control panel shall have a degree of protection IP-54 as per 01-SDMS-01.

4.8.3 The control panel shall be constructed as a single unit and be capable of being removed from the enclosure without disconnecting components or shall be capable of being disconnected from the control cable.

4.8.4 Conductors of control cable shall be color coded or labeled for easy identification.

4.8.5 Electronic components shall be hermetically sealed, identified, reached easily for testing and capable of operating in high ambient temperature as per 01-SDMS-01.

4.8.6 The Voltage Regulator control panel shall be fully wired and ready for service and shall include the following facilities:

- Power Circuit Breaker.
- Internal/External power source selector switch.
- Off/Manual/Automatic motor transfer switch with five (5) positions.
- Band-width adjustable and independent of voltage setting.
- Static time delay variable 10 seconds to 120 seconds.
- Position indicator drag hand reset button.
- Neutral position indicator light.
- Band-width position indicating meter.
- Output voltage test terminals.
- External voltage source terminals.
- Line Drop Compensation.
- Six digit operating counter.
- Current testing means.
- Supervisory On/Off switch.
- Differential voltage PTs.
- Tap position indicator.



- Profile recorder.
- Voltage limiting accessory.
- Completely ready for remote communication.
- Metering.
- Calendar/Clock.
- Load voltage primary.
- Source voltage calculation.
- System line voltage.
- Load current primary.
- Load current secondary.
- Source voltage primary.
- Source voltage secondary.
- Power factor.
- kVA load.
- kW load.
- kVAR load.
- Regulator configuration.
- Control operating mode.
- Overall potential transformer ratio.
- Current transformer primary rating.
- Reverse power flow detector.
- Reverse power sensing mode.

4.8.7 A minimum five (5) meter of control cable shall be provided between the regulator and control box. The cable and controls shall be factory fitted to the regulator. The location of any plug on the cable shall be identified, but should preferably be at the control panel.

4.8.8 Control/Power Voltage transformers and Current transformers shall be supplied with the Regulator.

4.8.9 Inter-locking shall be provided to prevent energizing the high voltage terminals, in the event of an external 120V supply being applied to the control panel.

4.9 Accessories & Fitting

The Voltage Regulator shall have following accessories and fittings:



- 4.9.1 Temperature gauge shall be dial type with re-settable maximum indicator. Scale shall be from 0° C to 120° C.
- 4.9.2 External oil level indicator shall be a gauge that indicates oil level and color.
- 4.9.3 Draining valve shall be equipped with a non-detachable handle and protecting plug and shall be located at the bottom of the tank. A filling pipe shall be located above the full oil level, at the top of the tank. This pipe shall have internal threads and be fitted with a brass bung and gasket.
- 4.9.4 Lifting lugs shall be designed so that the Regulator can be lifted without damage to itself or to its fittings. All necessary fittings for mounting shall be supplied.
- 4.9.5 Step position indicator with upper and lower drag hands shall be mounted with the face at 45° downward slant for easy reading from ground level.
- 4.9.6 A voltage limit control shall be provided that prevents the Regulator from further raising its output above, or going below the preset values of the limit control once the limit is reached.

5.0 MARKING

Each Voltage Regulator shall be provided with an easily readable nameplate of weatherproof material showing the following details indelibly marked in English and Arabic:

- Manufacturer's type, model & catalogue number.
- Serial Number/Year of manufacture
- Number of Phases
- Rated kVA
- Rated Frequency.
- Rated Current.
- Rated Voltage.
- Rated Range of Regulation.
- Rated impulse withstand voltage.
- Number of Steps Plus/Minus.
- Volume of insulating fluid.
- Conductor material.
- Complete diagrams showing the leads and internal connections and their markings,



including polarity markings, and the voltage obtainable with the various connections.

- Gross weight.
- P.O. Number.

6.0 INSPECTION AND TESTING

6.1 In addition to the requirements specified in 01-SDMS-01, the following shall be fulfilled:

6.1.1 The Supplier shall make adequate routine tests and inspections to determine the conformity of material furnished under this Specification with the requirements invoked.

6.1.2 Inspection/Routine Test Requirements.

6.1.2.1 Inspection/Routine tests shall be in accordance with the applicable standards in this specification.

6.1.2.2 Visual inspection shall include checks for satisfactory workmanship, materials, and freedom from surface defects and for compliance with the Purchase Order and the General Specification.

6.1.2.3 SEC representative may conduct acceptance inspection and witness testing at the manufacturer's plant or conduct testing at SEC facilities. However, inspection and acceptance shall not relieve the supplier of his responsibility for conformance with this specification.

6.1.2.4 SEC representative shall have a free access at any time while work is being carried on, to all areas of the supplier's plant, which concern the work.

6.1.2.5 Inspection/routine tests may be made during any stage of manufacturing and shipping.



6.1.2.6 Material shall be type tested, in an independent testing laboratory or at manufacturer's laboratory witnessed by SEC representative, in accordance with the requirement of the latest standards in this specification.

6.2 Tests

6.2.1 Type Tests

The Voltage Regulators offered shall be Type Tested in accordance with the requirements of the Standards listed in the following table. The peak value of the chopped impulse shall be the same as for the full impulse.

| Type Test | Standard |
|---|-----------------|
| Test for Temperature Rise | IEEE Std C57.15 |
| Full-wave Impulse Voltage Withstand Test, including Chopped Waves | IEEE Std C57.15 |
| Noise Level Measurement | IEC-60551 |
| Radio Influence Voltage Measurement | IEC-60437 |
| Winding Insulation Requirement | ASTM D-202 |

6.2.2 SEC at its discretion, may waive Type Test requirements where Type Test have previously been carried out and test certificates are provided by the supplier.

6.2.3 Routine Tests

Routine Tests shall be carried out in accordance with IEEE Std C57.15, including the following tests, on all Voltage Regulators being supplied.

- Impedance and load loss at rated current and frequency.
- No-load (excitation) loss at rated voltage and frequency at all taps.
- Resistance measurement of all windings.
- Ratio test on all taps.
- Polarity and phase relation tests.



- Lightning impulse tests.
- Power frequency withstand tests.
- Induced voltage test.
- Manual and automatic operations with the Regulator fully assembled and with internal voltage supply.

7.0 PACKING AND SHIPMENT

- 7.1 Regulators shall be delivered ready for service with the control panel secured to the tank.
- 7.2 Regulators shall be packed in sea-worthy, non-returnable crates, designed to protect against mechanical damage and ingress of moisture and dust.
- 7.3 Regulators shall not be packed in any organic material.
- 7.4 Packing notes shall be included in each crate giving a description of the goods packed.
- 7.5 Components or materials, if subjected to a shelf life limitation, shall have the final date of use prominently shown on all cases.
- 7.6 Each crate shall be printed with the following information:
- Regulator catalog number.
 - Purchase Order number.
 - Manufacturer's name
 - Year of manufacture.
 - Gross weight.
 - Position of slinging points and other relevant handling instructions.

8.0 SPARE PARTS

- 8.1 A comprehensive list of manufacturer's recommended spare parts shall be included in the tender.
- 8.2 The quantities offered should be adequate for the initial five (5) years of operation.
- 8.3 A firm price and delivery period shall be quoted for each item.



8.4 Spares supplied shall be packed to provide long storage without deterioration. Each package shall be clearly marked in Arabic and English with the description of its contents.

8.5 If any spare part requires special storage conditions, these conditions shall be detailed.

9.0 GUARANTEE

The supplier shall guarantee the Voltage Regulators and control equipments against all defects arising out of faulty design, workmanship, or of defective material for a period of two (2) years from the date of delivery.

10.0 TRAINING

The supplier shall provide training at site, regarding programming and commissioning of the Voltage Regulator for an adequate period, to be agreed by SEC and supplier.

11.0 SUBMITTALS

11.1 Submittals Required With Tender

The Bidder shall submit the following along with the Tender.

- a) The Bidder shall fill-up and return one copy of Technical Data Schedule.
- b) Complete Type Test reports as per clause 6.2
- c) The Bidder shall provide relevant original catalogs giving details of equipments being offered and required accessories and maintenance requirements.
- d) Detailed drawings indicating:
 - Outlines of Voltage Regulator, positions of fittings and attachments. Details of H.V. terminals and Bushings, Mounting arrangements, and view of the Control Panel.
 - Outline drawings (2 copies) of H-pole arrangement and mounting of Regulators with disconnect and by-pass switches.
 - Schematic diagrams (2 copies) for Open-Delta connections for single phase regulators.
- e) The supplier/manufacturer shall clearly state and give a list of deviations or exceptions. Every deviation/exception shall indicate the applicable clause/section of this specification and/or associated specification and the reason for such deviation/exception.



- f) SEC reserves the right to reject any or all of the deviations/exceptions without assigning reasons.
- g) The bidder shall also quote the cost of one bypass/disconnect and one disconnect switch per each single phase voltage regulator, which shall be compatible with the regulator offered.

11.2 Submittals Required, Following Award Of Contract

The following submittals shall be provided by the Bidder after the Award of Contract.

- a) Details of Manufacturing and Test Schedules.
- b) Factory test reports.



12.0 TECHNICAL DATA SCHEDULE
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| Ref # | DESCRIPTION | SEC SPECIFIED VALUE | | VENDOR PROPOSED VALUE |
|----------|---|---|---|-----------------------|
| 1 | GENERAL | | | |
| 1.1 | Nominal system voltage | 13.8kV | 33kV | |
| 1.2 | Maximum continuous operating voltage | 15.2kV | 36.3kV (38kV) | |
| 2 | DESIGN AND CONSTRUCTION REQUIREMENTS | | | |
| 2.1 | Rating | Corresponding to required current rating & regulation | Corresponding to required current rating & regulation | |
| 2.2 | Rated range of regulation - open delta - Closed delta | ±10% ±15% | ±10% ±15% | |
| 2.3 | Number of steps | 32 | 32 | |
| 2.4 | Rated voltage | 13.8 kV | 33 kV | |
| 2.5 | Rated current | As stated in tender | As stated in tender | |
| 2.6 | Rated frequency | 60 Hz | 60 Hz | |
| 2.7 | Impedance voltage | 0.5% of rated voltage (max) | 0.5% of rated voltage (max) | |
| 2.8 | Continuous ambient temperature at which ratings apply | 55° C | 55° C | |
| 2.9 | At rated kVA: | | | |
| | i) Average winding temperature rise | 55° C | 55° C | |
| | ii) Top oil temperature | 50° C | 50° C | |
| | iii) Hot spot temperature rise | 95° C | 95° C | |
| 2.10 | Core loss at maximum raise tap | | | |
| 2.11 | Winding loss at maximum raise tap | | | |

**12.0 TECHNICAL DATA SCHEDULE**

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| | | | | |
|----------|--|-------------------------------|---------------|--|
| 2.12 | Magnetizing current | _ A | _ A | |
| 2.13 | Bushing power frequency withstand | 38 | 70 | |
| 2.14 | BIL of Bushing | 95, 110 | 170, 200 | |
| 2.15 | Creepage of Bushing | 345mm, 552mm | 825mm, 1320mm | |
| 2.16 | Tank steel thickness | 3mm (minimum) | 3mm (minimum) | |
| 2.17 | Weight of completely assembled regulator (kg) | | | |
| 2.18 | Weight of oil (kg) | | | |
| 2.19 | Operating pressure of relief device (kN/m ²) | | | |
| 3 | MARKING | | | |
| 3.1 | Nameplate marking as per spec. | Yes | | |
| 4 | INSPECTION AND TESTING | | | |
| 4.1 | Meets all sub-clauses in spec. | Yes | | |
| 4.2 | Meets all tests required in spec. | Yes | | |
| 5 | PACKING AND SHIPMENT | | | |
| 5.1 | Net weight (kg) | By Vendor | | |
| 5.2 | Markings as per spec. | Yes | | |
| 6 | SPARE PARTS | | | |
| 6.1 | List of spare parts | Yes | | |
| 7 | GUARANTEE | | | |
| 7.1 | Guarantee period from delivery date | 2 Years | | |
| 8 | SUBMITTALS | | | |
| 8.1 | All submittals as per spec. | Yes/No (If 'No' give details) | | |



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12.0 TECHNICAL DATA SCHEDULE
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SEC Inquiry No:

Item No:

- A. Additional Technical Information or Features Specified by SEC.
- B. Additional Supplementary Data or Features Proposed by Bidder/Vendor/Supplier.
- C. Other Particulars to be filled-up by the Bidder/Vendor/Supplier.
- D. List of Deviations and Clauses to which exception is taken by the Bidder / Vendor / Supplier. (Use separate sheet, if necessary).

| Description | Manufacturer of Material/Equipment | Vendor/Supplier |
|---|------------------------------------|-----------------|
| Vendor/Supplier | | |
| Vendor/Supplier | | |
| Name and Signature of Authorized Representative with Date | | |
| Official Seal / Stamp | | |