To,
All PIAs

Sub: Clarification on Technical Specification & standard drawing and categorization of materials for pre dispatch inspection under XII Plan RE component of DDUGJY

Ma’m/Sir,

In response to request by various agencies, few clarifications on XII Plan projects under erstwhile RGGVY are given hereunder:

- 33 KV Railway crossing drawing is to be developed by turn-key contractor matching with local Railways’ specifications / drawings and approved by PIA. All required materials are available in BoQ.
- 33 KV River crossing drawing – Depending on span, turn-key contractor shall develop drawings for line and approved by PIA. All required materials are available in BoQ.
- The cut point on 33 KV single pole is not recommended. Instead, 33 KV DP structure may be used. The drawing of 33 KV DP structure is enclosed herewith.
- Civil foundation drawing for various equipment including power transformer foundation shall be developed by turn-key contractor matching with OEM requirements and approved by PIA. Necessary concreting items are available in BoQ.
- Electrical layout with distance drawing for new PSS is site specific issue. Hence, it may be developed by turn-key contractor and approved by PIA. General arrangements are available in SBD at 'REC-XII Plan-Gen-43’ in Volume-II : Section-III.
- Technical specifications for lightening mast are given in SBD. Please install flood light fittings focusing substation area at site.
- Internal electrification drawing showing main DB, sub DB, switchboard etc shall be developed by turn-key contractor and approved by PIA. Technical specifications for

Zonal Offices : Hyderabad, Kolkata, Mumbai, Panchkula & Lucknow
Project Offices : Bangalore, Bhopal, Bhubaneswar, Chennai, Guwahati, Jaipur, Jammu, Patna, Ranchi, Shillong, Shimala, Thiruvananthapuram & Vadodara
Sub Offices : Dehradun, Raipur
Training Centre : Central Institute for Rural Electrification (CIRE), Hyderabad
key IE materials are covered under SBD. Illumination intensity are given in scope of work to be ensured while designing the lighting.

- Testing equipment’s technical specification are to be finalized in line with details provided under scope of works in SBD by PIA.
- 33 KV XLPE cable technical specification is enclosed.
- Technical specification of LT distribution box provided with name of LT switch board for 63 KVA & 100 KVA transformers in SBD at S. No. 17, page no Q in Volume-II : Section-II. Its drawing is to be developed by turn-key contractor and approved by PIA.
- Station transformer - The technical specification of 100 KVA, 33/0.433 KV station transformer has been provided in SBD and it is also covered under BoQ. Hence, station transformer of 100KVA, 33/0.433 KV is to be used instead of 100KVA, 11/0.433 KV transformer.

In SBD, the guidelines for 3-tier Quality Assurance Mechanism (QAM) have been defined in Volume-II : Section –IV. In QAM guidelines, important materials have already been identified in clause 1.1 for VEI & REDB. Under tier-I, the agency has to conduct pre-dispatch inspections against these important materials only.

Thanking You,

Yours Sincerely,

G S Bhati
General Manager (DDUGJY)

Encl.: 1. 33 KV DP structure drawing
2. 33 KV XLPE cable technical specification
XLPE POWER CABLES (33KV)

SECTION I

STANDARD TECHNICAL REQUIREMENT

1.0 SCOPE:

This section covers the standard technical requirements of design, manufacturing, testing, packing and dispatching of 33 kV XLPE HT Power Cable.

2.0 APPLICABLE STANDARDS

The materials shall conform to the latest editions of the following Indian/International Standards:

IS 7098 Part 2: 1985 XLPE insulated PVC sheathed cables For working voltages from 3.3 kV up to and including 33 kV

IS 5831: 1984 PVC Insulation and Sheath of Electric Cables

IS 8130: 1984 Conductors for insulated electric cables and flexible cords.

IS 613: 1984 Copper rods and bars for electrical purposes.

IS 3975: 1988 Mild steel wires, formed and tapes for armouring of cable.

IS 10810: 1984 Method of tests for cables.

IEEE-383: 1974 Standard for type test of class IE electric cables, field splices, and connections for nuclear power generating stations.

ASTM-D2843, 1993 Standard test method for density of smoke from burning or decomposition of plastics.


NEMA-WC5, 1992 Thermoplastic Insulated Wire and cable for the transmission and distribution of Electrical Energy.

IEC: 754 Test on gases evolved during combustion of electric cables -


IEC: 332 Test on electric cables under fire conditions

(Part I): 1993 Test on a single vertical insulated wire or cable.

IS 3961 Recommended current rating for cables -
(Part II): 1967 PVC insulated and PVC sheathed heavy duty cables.

IS 10418:1982 Drums for electric cables.

3.0 GENERAL REQUIREMENTS

All cables shall be suitable for high ambient, high humid tropical Indian Climatic conditions. Cables shall be designed to withstand the mechanical, electrical and thermal stresses under the unforeseen steady state and transient conditions and shall be suitable for proposed method of installation.

Conductor shall be of uniform, of good quality, free from defects Aluminium copper.

Insulation shall be Cross Linked Polyethylene (XLPE).

For 33 kV and 11 kV cables, conductor screen and insulation screen shall both be extruded, semi-conducting compound and shall be applied along-with XLPE insulation in a single operation by triple extrusion process. Method of curing for 33 kV cable shall be "Dry curing/ gas curing " only.

Cable shall be provided with copper metallic screen suitable for carrying earth fault current as stipulated in Clause-1.2 of Section 1. For single core armoured cables the armouring shall constitute the metallic part of the screening.

Inner sheath - All armoured and multi-core un-armoured cables shall have distinct extruded inner PVC sheath of black colour.

Armouring - Material for armour for Single Core Cable shall be Aluminum wire. For Multicore cable it shall be GS wire / flat. Armouring shall be as per relevant IS and it shall have minimum 90% coverage.

Breaking Load of the joints shall be minimum 95% of the normal armour.

Outer Sheath – It shall be of black colour PVC (type ST2 as per IS 5831) with Cable size and Voltage grade embossed on it. Sequential marking shall be at every 1 (one ) Meter distance. Word "FRLS" shall also be embossed on it at every 5 (Five ) meter distance.

FRLS Properties - All cable shall be Flame Retardant, Low Smoke (FRLS) type. Outer sheath shall have the following properties –

Acid Gas Generation – Max 20% (as per IEC 754-1)

Smoke density rating: 60% (As per ASTMD 2843)

Flammability test - As per Swedish chimney test F3 as per SEN 4241475

As per IEC 332 part-3 (Category B)

Minimum bending radius shall be 10 D

Repaired cables shall not be acceptable.

4.0 CURRENT RATING OF CABLES
4.1 Normal current rating shall not be less than that covered by IS 3961. Vendor shall submit data in respect of all cables in the prescribed format.

4.2 Tables given de-rating factors for various conditions of cable installation including the following, for all types of cables shall be furnished.
- Variation in ambient air temperature.
- Variation in ground temperature.
- Depth of laying.
- Cables laid in the ground
- Cables laid in trench
- Cables laid in ducts
- Soil resistivity.
- Grouping of cables.

4.3 The value of short circuit withstand current ratings of all cables shall be indicated for a short circuit for 1 second duration and should also specify the maximum temperature during short circuit.

4.4 The following factors shall also be accounted for, while specifying the maximum short circuit withstand of the cables.

4.5 Deformation of the insulation, due to thermo-mechanical forces produced by the short circuit conditions, can reduce the effective thickness of insulation.

4.6 Conductor and core screens can be adversely affected with loss of screening effect. Likewise the thermal properties of the outer sheath material can be the limitation.

4.7 It is essential that the accessories which are used in the cable system with mechanical and/or soldered connections are suitable for the temperature adopted for the cables.

4.8 Formula for calculating short circuit current for different duration or curve showing short time current vs time for different sizes of cables shall be furnished by vendor.

5.0 CABLE DRUMS

5.1 Cables shall be supplied in non-returnable wooden or steel drums of heavy construction and drum shall be properly seasoned, sound and free from defects. Wood preservative shall be applied to the entire drum.

5.2 All Power Cables shall be supplied in drum length of 1000 m. Each drum shall contain one continuous length of cable. Owner shall have the option of rejecting cable drums with shorter lengths. The cable length per drum is allowed a tolerance of ±5%. The tolerance allowed on total quantity of each size is as given below.

a) 50 meters for cable length upto 10 kms.

b) 100 meters for cable length more than 10 kms. and up to 20 kms.

c) 150 meters for cable length more than 20 kms.

Where the ordered quantity is not multiple of 1000 m and the incremental quantity is very small, the same may be included in one of the drums. Otherwise, an additional length for the incremental quantity will be supplied.

5.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable
layer.

5.4 A clear space of at least 40mm shall be left between the cables and the logging.

5.5 Each drum shall carry manufacturer’s name, purchaser’s name, address and contract number, item number and type, size and length of the cable, net and gross weight stenciled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wordings shall be marked on one end of the reel indicating the direction in which it should be rolled.

5.6 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

6.0 TESTS

6.1 Type Tests

The following shall constitute type tests:

a. Tests on conductor
   i. Annealing test (for copper)
   ii. Tensile tests (for aluminium)
   iii. Wrapping tests (for aluminium)
   iv. Resistance test
b. Tests for armouring wires/straps

c. Test for thickness of insulation and sheath

d. Physical tests for insulation
   i. Tensile strength and elongation at break
   ii. Ageing in air oven
   iii. Hot test
   iv. Shrinkage test
   v. Water absorption (gravimetric)

e. Physical tests for out sheath
   i. Tensile strength and elongation at break
   ii. Ageing in air oven
   iii. Hot test
   iv. Shrinkage test

f. Bleeding and blooming tests (for outer sheath)

g. Partial discharge test

h. Bending test

i. Dielectric power factor test
   i. As a function of voltage
   ii. As a function of temperature

j. Insulation resistance (volume receptivity) tests

k. Heating cycle test

l. Impulse withstand test

m. High voltage test

n. Flammability test
6.2 Acceptance tests

The following shall constitute acceptance tests:

a. Annealing test (for copper)
b. Tensile test (for aluminium)
c. Wrapping tests (for aluminium)
d. Conductor resistance test,
e. Test for thickness of insulation
f. Hot set test for insulation,
g. Tensile strength and elongation at break test for insulation and sheath
h. Partial discharge test (for screened cables only)
i. High voltage test and
j. Insulation resistance (volume resistively) test

6.3 Routine test

The following shall constitute routine tests:

a) Conductor resistance test
b) Partial discharge test (for screened cables only) and
c) High voltage tests.

6.4 Optional tests

Cold impact tests for outer sheath (IS:5831-1984) shall constitute the optional tests.

SECTION II

SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES.

2.0 SCOPE

This section of the specification covers project information, site condition, desired Technical parameters and quantity of XLPE Cable.

2.1 Project Information

a) Customer:
b) Engineer/Consultant:

c) Project Location:

e) Transport facilities

- Nearest Railway station: /Gauge

- Distance from site:

f) Access Roads:

2.2 SITE CONDITIONS

a) Ambient air temp. (max.) ºC:

b) Ambient air temp. (min.) ºC:

c) Design ambient temp. ºC:

2.2.1 Relative humidity for design purposes

2.2.2 Height above mean sea level in meters

2.2.3 Earth quake data

a) Seismic zone: IS:1893-84

b) Seismic acceleration: As per IS

2.2.4 Wind data

a) Site Wind Pressure Kgf/m²: As per IS

2.3 System Particulars

a. Line Voltage (kV) 33
b. Highest System Voltage (kV) 36
c. Number of Circuits 1
d. Frequency HZ50
e. Neutral effectively earthed
f. Short circuit level (KA) 22.77 KA, 31.8KA / 22.5KA, 45KA
2.4 SPECIFIC TECHNICAL REQUIREMENTS

Technical Parameters of the cable shall be as follows:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>PARTICULAR</th>
<th>Unit</th>
<th>DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rated Voltage</td>
<td>kV</td>
<td>19.0/33</td>
</tr>
<tr>
<td></td>
<td>Type of Insulation</td>
<td></td>
<td>XLPE</td>
</tr>
<tr>
<td></td>
<td>Single core/ Multi core</td>
<td></td>
<td>Single/Three core</td>
</tr>
<tr>
<td></td>
<td>Armoured / Unarmoured</td>
<td></td>
<td>Armoured</td>
</tr>
<tr>
<td></td>
<td>Material of Conductor</td>
<td></td>
<td>Aluminium/Copper</td>
</tr>
<tr>
<td></td>
<td>System</td>
<td></td>
<td>33 kV Earthed</td>
</tr>
<tr>
<td></td>
<td>Highest System Voltage</td>
<td>kV</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Conductor size</td>
<td>sq. mm</td>
<td>150, 185, 240, 300, 400</td>
</tr>
<tr>
<td></td>
<td>Material</td>
<td></td>
<td>Stranded Aluminium/copper</td>
</tr>
<tr>
<td></td>
<td>Shape of Conductor</td>
<td></td>
<td>Circular</td>
</tr>
<tr>
<td></td>
<td>Short Circuit Current</td>
<td>kA</td>
<td>13.12, 26.24 for 3 secs</td>
</tr>
<tr>
<td></td>
<td>Power Frequency Withstand</td>
<td>KV rms</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lightning Impulse Withstand</td>
<td>kVp</td>
<td>170</td>
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<tr>
<td></td>
<td>Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuous Withstand</td>
<td>Deg C</td>
<td>90</td>
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<tr>
<td></td>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short Circuit withstand</td>
<td>Deg C</td>
<td>250</td>
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<tr>
<td></td>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxygen Index</td>
<td></td>
<td>Min 29 (as per ASTMD 2863)</td>
</tr>
<tr>
<td></td>
<td>Acid Gas Generation</td>
<td></td>
<td>Max 20% (as per IEC 754-1)</td>
</tr>
<tr>
<td>14</td>
<td>Smoke Density Generation</td>
<td></td>
<td>60% (As per ASTMD 2843)</td>
</tr>
<tr>
<td>15</td>
<td>Flammability Test</td>
<td></td>
<td>As per Swedish Chimney test</td>
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</table>

2.5 QUANTITIES

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item Description</th>
<th>Quantities(m)</th>
</tr>
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<tbody>
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</tbody>
</table>

SECTION III

GUARANTEED TECHNICAL PARTICULARS

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Item Particulars</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacturers Name &amp; Address</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Country of manufacturer</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Type of cable</td>
<td></td>
</tr>
</tbody>
</table>
4 Applicable standards for manufacturing
5 Applicable standards for testing
6 Rated voltage kV
7 Maximum service voltage kV
8 Maximum continuous current carrying capacity per cable when laid in air at an ambient air temperature of 50 deg. (single core cables solid bonded)
9 Maximum continuous current carrying capacity per cable when laid in ground at a depth of 1.0 m (ground temp. 40 deg. C and soil thermal resistivity of 150 deg.c/watt/cm max. Conductor temp. 90 deg. C) (single core cables solid bonded)
10 Maximum continuous current carrying capacity per cable when drawing into duct/pipes (single core cables solid bonded)
11 Maximum continuous current carrying capacity per cable when laid in covered RCC trenches at an ambient temperature of 50 Deg. C laying conditions to be specified (Single core cables solid bonded)
12 Short circuit withstand capacities for 1 second of (With a conductor temperature of 90 Deg. C at the commencement
   i) Conductor KA
   ii) Screen KA
   iii) Armour KA

13 Conductor
   i) Material & Grade
   ii) Nominal cross - sectional area sq.mm
   iii) No. of strands
   iv) Diameter of each strand (Nominal) mm
   v) Max. DC resistance of conductor at 20 Deg. C ohm/km
   vi) Max. AC resistance of conductor at 90 Deg. C ohm/km

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Item Particulars</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reactance of cable at normal frequency (Approx)</td>
<td>ohm/km</td>
</tr>
<tr>
<td></td>
<td>Electrostatic capacitance at normal frequency</td>
<td>microrfarads per km</td>
</tr>
</tbody>
</table>
Charging current

Loss tangent at normal frequency at \( U_0 \)

14Conductor screen
   i) Material
   ii) Nominal thickness \( \text{mm} \)

15XLPE Insulation
   i) Composition
   ii) Type of curing
   iii) Thickness of insulation (nominal) \( \text{mm} \)
   iv) Tolerance on thickness \( \text{mm} \)
   v) Dielectric constant at normal frequency
   vi) Specific insulation resistance at 20 deg. C \( \text{ohm/km} \)
   vii) Min. Volume resistivity at 20 deg. C
   viii) Min. Volume resistivity at 90 deg. C
   ix) Min. Tensile strength \( \text{kg/sq.cm} \)
   x) Min. Elongation percentage at rupture \( \% \)
   xi) Identification of cores

161.2/50 microsecond impulse wave withstand voltage \( \text{kVp} \)
175 min. power frequency withstand voltage \( \text{kV} \)
18Max. Dielectric stress at the conductor \( \text{kV/cm} \)
19Max. Dielectric stress at the conductor screen \( \text{kV/cm} \)

20Insulation screen
   i) Material
   ii) Extruded/wrapped
   iii) Nominal thickness \( \text{mm} \)
   iv) Colour

21Metallic screen
   i) Material / composition
   ii) Nominal radial thickness / dia

22Nominal diameter over metallic screen \( \text{mm} \)
23Nominal radial clearance allowed under metal sheath \( \text{mm} \)
24Type and material of filler
25Armour
   i) Material and type
   ii) Dia