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INDEPENDENT POWER TRANSMISSION OPERATOR S.A.
NTPD/ SPECIFICATIONS & EQUIPMENT SECTOR S/S – EHV S/S

TECHNICAL DESCRIPTION TD-74
SINGLE CORE UNDERGROUND 26/45(52)KV CABLES
WITH CROSS - LINKED POLYETHYLENE INSULATION (XLPE)

I. SCOPE

This hereby technical description sets forth the required technical and constructional characteristics of single core underground 26/45(52)KV cables with cross- linked polyethylene insulation (XLPE) and aluminium conductor of 1200mm² cross - section and also sets forth the required tests for the cables in question.

II. KEYWORDS

Underground cables, high voltage cables with cross - linked polyethylene insulation.

III. STANDARDS

The applicable standards for the cables shall be the IEC – 60840 and IEC-60183

IV. USE

The cables are to be used inside ehv substations for the connection of 30KV shunt reacrors to the 30KV tertiary winding of 400/150/30 KV autotransformers.

V. SYSTEM CHARACTERISTICS

The cables are to be used in a electrical power system which has the following characteristics:

- | | |
|---|--|
| 1. Rated system Voltage (phase-to-phase) | :30 KV rms |
| 2. Maximum operating system Voltage | :36 KV rms |
| 3. Basic Insulation Level (BIL) (Impulse level) | :250 KV crest |
| 4. Frequency | :50 Hz |
| 5. Number of phases | :3 |
| 6. Short Circuit level | :20KA |
| 7. Time duration of short circuit | :1 sec |
| 8. Method of Earthing | :The 30 KV system
is solidly earthed
(grounded) only
when at least one
30KVshunt reactor
is in service. |

VI. SOIL CHARACTERISTICS AND AMBIENT AIR TEMPERATURES

The smaller section of the cable is to be laid in the soil which has the following characteristics:

- | | |
|-----------------------------|--|
| 1. Soil thermal resistivity | : $\leq 1,2^0 \text{ Km/W}$ |
| 2. Average soil temperature | : $+20^{\circ}\text{C}$ |
| 3. Soil temperature range | : $+10^{\circ}\text{C to } +30^{\circ}\text{ C}$ |

The larger section of the cable shall be installed in air and will experience the following ambient temperature variations. : $- 25^{\circ}\text{C to } +45^{\circ}\text{ C}$

1. Ambient air temperature range

VII. CABLE INSTALLATION CHARACTERISTICS

Details of the cable installation in the soil and in the air

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|---|------------------|
| 1. Number of circuits | : One |
| 2. Cable arrangement in the soil | : flat formation |
| 3. Distance between phases (center to center) | : 25cm |
| 4. Laying depth | : 1.0m |
| 5. Metallic sheath earthing method | : Single point. |

6. Furthermore, the portion of the cables which will be laid directly into the soil shall be laid directly and will be covered by quarry sand and cement plates.

VIII. CABLE REQUIRED CHARACTERISTICS

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|--|---|
| 1. Rated Voltage, $U_o / U(U \text{ max})$ | : 26/45(52)KV
where U_o =Voltage between conductor and earth or metallic sheath(rms),
U = phase - to- phase rms value , $U \text{ max}$ =maximum phase to - phase voltage (rms) |
| 2. Impulse withstand voltage (1.2/50ms) | : 250KV peak |
| 3. A.C 50Hz voltage withstand for 30 minutes | : 65KV rms |

- | | |
|---|---|
| 4. Basic components of the cable | : The cable shall consist of the following basic parts:
Conductor, a semi conducting conductor layer, XLPE insulation, a semiconducting insulation layer, screen of copper wires, a semi conducting layer for the screen of copper wires, aluminium tape, a swelling tape or material and an outer sheath consisting of polyethylene (PE). |
| 5. Continuous current carrying capability of the cable
: $\geq 1000\text{A}$ | |

IX. REQUIRED CHARACTERISTICS OF THE CABLE CONDUCTOR

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|---|---|
| 1.Number of conductors | : One(1) |
| 2.Conductor material | : Aluminium |
| 3.Cross section of the conductor | : 1200 mm ² . |
| 4.Conductor shape and composition | : Circular in shape, multi -wire consisting of circular stranded compacted wires in accordance with IEC-60228. |
| 5.Conductor Insulation | : The insulation of the conductor shall consist of super clean extruded layer of cross -linked polyethylene (XLPE). The mechanical characteristics of the insulation shall be in accordance with the values of table IV of IEC - 60840. |
| 6. Conductor withstand in short circuit current | : 20 KA for 1 sec, minimum |

X. CABLE'S METALLIC SHEATH REQUIRED CHARACTERISTICS AND PROTECTION REQUIREMENTS FOR THE CABLE AGAINST WATER AND MOISTURE

- | | |
|---|--|
| 1. Metallic sheath material | :Screen of copper wires for charging currents and short circuit currents. |
| 2. Radial protection of the cable against water and moisture | :Aluminium tape of at least 0,2mm in thickness, on top of the screen of copper wires. |
| 3. Longitudinal protection of the cable against water and moisture | :The longitudinal protection against water and moisture shall be achieved by the use of swelling tape or material. |
| 4. Screen of copper wires withstand capability in short circuit current | :20 KA for 0.5 seconds. |

XI. SEMICONDUCTING LAYERS FOR CONDUCTOR AND INSULATION OF THE CABLE

The semiconducting conductor and insulation layers are both compulsory and they must be produced together during production with the triple extrusion method.

XII. OUTER SHEATH OF THE CABLE

The outer cable sheath will be manufactured with the method of extrusion from polyethylene (PE) of black color. It's outer surface shall be made conducting with the addition of proper conducting layer with the method of extrusion.

XIII CABLE MARKINGS

1. The cable must bear on its outer sheath the following markings:
 - Manufacturers trade mark
 - Cross - section and material of the conductor
 - Insulation material
 - Rated voltage U_0/U (U_{max})
 - Year of manufacturing
 - Contract number
2. Furthermore, the outer cable sheath shall bear indication of total progressive length count per meter length for the total length of cable ordered. The indication must be indelible written with engraved characters/ numerals. The minimum height of the characters/numerals shall be 4mm.

XIV. TESTS

The routine, special and type tests shall be in accordance with IEC - 60840.

A. Routine tests

The following tests shall be carried out on each manufactured length of cable.

1. Partial discharge test
Test voltage : 39KV
2. Voltage test (dielectric test for 30 minutes).
Test voltage : 65KV

B. Special Tests

The following tests shall be made on only one representative cable sample.

1. Conductor examination
2. Measurement of electrical resistance of conductor.
3. Measurement of thicknesses of insulation and non - metallic layers.
4. Measurement of thickness of the metallic sheath
5. Measurement of conductor's and cable's diameter.
6. Hot set test for XLPE.
7. Measurement of capacitance.

C. Type Tests

The type tests shall be made before the manufacturer begins the continual production of the cable.

1. Electrical tests on complete cable

The tests listed below shall be performed on samples of complete cable at least 10m in length.

With the exception of the measurement of $\tan \delta$ all other tests must be applied successively to the same sample.

The sequence of tests and the tests shall be as follows:

- a. Bending test followed by partial discharge test
- b. $\tan \delta$ measurement
Test voltage : 26KV
- c. Heating cycle voltage test, followed by partial discharge measurement.
Test voltage : 52KV
- d. Impulse withstand test followed by a power frequency voltage test.
Impulse test voltage : 250KV peak, followed by a test voltage of 65KV.

XV PACKING

The cable shall be wound on a reel and shall be protected against damage during transportation to its destination site.

Each end of each cable length must be sealed water -tight immediately after the testing.

The reels which must be supplied by the manufacturer must be metallic and of robust construction, with steel axes capable of withstanding the mechanical stresses exerted during the installation of the cable.

The reel axis hole shall have a diameter not less than 80 mm.

Each reel must bear either directly on it or on a non corrosive metallic plate the following markings.

- cable length
- unwinding direction
- Net and gross weight
- Contract number

XVI INFORMATION WHICH MUST BE PROVIDED BY ALL BIDDERS

1. The supplier must provide complete technical data along with the technical offer as it is required in attachment "A".

Offers which will have not completely filled attachment "A" shall be rejected.

2. A preliminary drawing of cross - section of the cable offered, with full description (legend). Failure to comply with this request will result in rejection of the offer.
3. Technical prospectus of the offered cable and its components, such as joints, etc.
4. Any available type test certificates for the type tests specified in this hereby technical description. Acceptance or not shall lie at the judgment of IPTO.
5. A complete study, based on IEC-60287, for the determination of the current carrying capability of the cable for the conditions specified in this hereby technical description.

Failure to comply with this request will result in rejection of the offer.

XVII. INFORMATION WHICH MUST BE PROVIDED BY THE SUCCESSFUL BIDDER

1. A detailed drawing depicting a cross-section view of the cable offered and complete description of all of its parts.
2. Detailed instructions regarding bending, handling, and installation of the cable.

XVIII. WARRANTY PERIOD

The supplier must provide a warranty period consisting of three (3) years beginning from the delivery date of the cable

ATTACHMENT "A"

Failure to provide all
information will result in

rejection of the offer.

A. Conductor

1. Nominal conductor cross sectionmm²
2. Conductor material
3. Minimum outer diametermm
4. Maximum outer diametermm
5. DC resistance at 20⁰ C $\mu\Omega/m$
6. AC resistance at 90⁰ C $\mu\Omega/m$
7. Number of wires
8. Nominal diameter of each wiremm

B. Semiconducting layers

Conductor semiconducting layer

1. Nominal thicknessmm
2. Minimum outer diametermm
3. Maximum outer diametermm
4. Specific electrical resistancemm
5. Material of the semiconducting layer $\Omega.m$

Insulation semiconducting layer

1. Nominal thicknessmm
2. Minimum outer diametermm
3. Maximum outer diametermm
4. Specific electrical resistancemm
5. Material of the semiconducting layer $\Omega.m$

Screen of copper wires semiconducting layer

1. Nominal thicknessmm
2. Nominal average diametermm
3. Specific electrical resistance $\Omega.m$
4. Material of the layer

C. Insulation

1. Material of the insulation
2. Nominal thicknessmm
3. Minimum outer diametermm
4. Maximum outer diametermm
5. Maximum dielectric stressKV/mm

D. Metallic sheath

Screen of copper wires

1. Nominal thickness of the screenmm
2. Minimum outer diameter of the screenmm
3. Maximum outer diameter of the screenN/mm²
4. Tension strength
5. Diameter of each wire

E. Cable outer sheath

Polyethylene (PE) sheath

1. Nominal thickness of PE

2. Material and method of application of
the conducting sheath

.....mm

F. Cable

1. Maximum outer diameter of the single core cable

.....mm

2. Minimum outer diameter of the single core cable

3. Cable inductive reactance (XL) $\mu\Omega/\text{KV}$

4. Capacitance at full load $\mu\text{F}/\text{KV}$

5. Maximum continuous circuit (3 cables) current
based on the data of this hereby technical
description, conductor temperature of 90°C and
the metallic sheath earthed at one endA

6. Maximum continuous circuit (3 cables) current
based on the data of this hereby technical
description, conductor temperature of 65°C and
the metallic sheath earthed at one endA

7. Maximum continuous circuit (3 cables) current
based on the data of this hereby technical
description, conductor temperature of 90°C and
the metallic sheath earthed at both endsA

8. Weight of the cableKg/m

9. Minimum bending radius

10. Positive sequence impedance of
one circuit (3 cables) ($Z_1 + JR_1$)

11. Zero sequence impedance of
one circuit (3 cables) ($Z_0 + JR_0$)

12. Losses (for one cable)
- in the conductor (on load)W/m
- in the screen of copper wires (on load)W/m
- dielectric (no load)W/m

13. Losses for one circuit (3-cables)
 - in the conductors (on load)W/m
 - in the screens of copper wires sheath (on load)W/m
 - dielectric (no load)W/m
14. Short circuit current capability
 - in the conductorKA for 1 sec
 - in the screen of copper wires
(metallic sheath)KA for 0.5 sec
15. Impulse withstand voltageKV
16. Maximum pulling tensiondaN
17. A.C 50 Hz voltage withstand
for 30 minutes
18. Does the offered cable meet all the
requirements of paragraph XIII?