DELHI METRO RAIL CORPORATION LIMITED

DMRC ELECTRICAL STANDARDS & DESIGN WING (DESDW)

SPECIFICATION NO.

DMES- T/0019/ DMRC-E-TR- CABLE-3

SPECIFICATIONS FOR 25 kV CABLES FOR ELEVATED AND UNDERGROUND CORRIDOR

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1. DETAILED DESCRIPTION OF THE EQUIPMENT AND ITS APPLICATION IN DMRC - 25 KV CABLES

1.1 These specifications are applicable to 25 kV cables in various corridors, constituting the 25 kV Traction Power supply distribution and Overhead Equipment Traction network.

25 kV Cables are generally required for the following connections:

- From Traction Transformer Secondary to 25 kV Switchgear in the TSS
- Connections between 25 kV equipments, as necessary, in the TSS
- At locations of FP, SSP, SP & SS interrupters and isolating switches
- Any other location as required

1.2 Cable of copper conductor with cross section of 240 sq. mm. is generally used; however different cross section may also be used as required.

1.3 Current rating for cables shall be determined taking into consideration the following installation methods as applicable:

- In the tunnels
- In cast –in pipes
- Trenches
- On brackets
- Ducts

And on the following as per design data:

- temperature correction
- thermal resistivity
- laying depth
- cable distance
- cable grouping factor etc

2. GOVERNING SPECIFICATIONS

25 kV Cables shall conform to IEC 60840 with specified voltage as ***26/45 kV (52 kV)*** grade.

2.1 *Standards*

The 25 kV Cables shall satisfy the requirements given below and shall also comply with standards in force when the cables are manufactured, particularly which are in the following table. (Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable): -

Standard #	Description
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) - Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)"
IEC 60228	Conductors of insulated cables
IEC 60840	Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) - Test methods and requirements
ASTM D 2843	Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics
ASTM D 2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
IS 7098 Part 2	Cross linked polyethylene insulated thermoplastic sheathed cables, Part 2: for working voltages from 3.3 KV up to & Including 33 KV.

2.2 *Abbreviations*

IEC – International Electro technical Council
ASTM- American Society for Testing and Materials
IS- Indian Standard
TSS – Traction Sub Station
ASS – Auxiliary Sub Station
RSS – Receiving Sub Station
OHE – Over Head Equipment
XLPE – Cross Linked Poly Ethylene
FRLS – Fire Retardant Low Smoke
FRLSZH – Fire Retardant Low Smoke Zero Halogen

FP – Feeding Post
SP- Sectioning Post
SSP – Sub Sectioning and Paralleling Post
SS – Sub Sectioning Station

3. TECHNICAL REQUIREMENT

3.1 25 kV cable shall be single core, 240 sq mm stranded copper conductor, XLPE insulated, copper wire screened, tape armouring, sheathed cables. It shall conform to IEC 60840 latest version for construction and testing. However different cross section may also be used as required.

- operating voltage: 25 kV rms between phase and Ground,
- specified voltage: 26/45 kV rms (according to IEC 60840)
- Copper conductor as per IEC 60228

3.2 The Contractor shall calculate and inform current rating to verify cross-sectional area of these cables as regard to the actual laying arrangement and design data mentioned in Para 1.3.

3.3 The various Constructional features required for the 25 kV cables are as under:

3.3.1 Conductor

The conductor shall be formed from annealed copper conductor with 240 mm^2 according to class 2 (compact circular stranded) complied with IEC 60228 latest publication.

3.3.2 Conductor screen

The conductor screen shall be non-metallic and shall consist of an extruded semi-conducting compound, which may be applied on top of a semi conducting tape. The extruded semi-conducting compound shall be firmly bonded to the insulation.

3.3.3 Insulation

The Insulation shall be XLPE. The insulation shall have a higher degree of Cross-Linking, free from contaminants and air voids, heat resistant and shall be applied by the extrusion process.

The XLPE insulation shall be suitable for use on power cable in wet and dry locations at conductor temperature as per IEC 60840. For this purpose, short circuit current in conductor is to be considered as 14 kA for 3 seconds.

The conductor with screening shall be provided with XLPE insulation applied by extrusion. The nominal thickness of insulation shall not be less than 10 mm subject to tolerance as per IEC – 60840, clause 10.6.2.

The insulation compound shall be of high quality, and shall be heat, moisture, ozone and corona resistant. XLPE compound should be from reputed manufacturer e.g. Borealis Sweden or NUC Japan or equivalent with satisfactory service experience of more than 5 years. The Insulation shall be applied by triple extrusion and vulcanized using dry curing process to form a compact homogenous body free from micro voids and contaminants.

3.3.4 Insulation Screen

The insulation screening shall be applied direct upon the insulation and shall be of a layer of extruded semiconducting thermosetting compound firmly and totally bonded to the insulation. Semiconducting compound should be from a reputed manufacturer e.g. Borealis, Sweden or NUC Japan or equivalent with satisfactory service experience of more than 5 years.

The conductor screen, insulation & insulation screen shall be extruded in a single process (triple extrusion).

The screen placed over the insulating envelope shall consist of a non-metallic semi-conducting part, associated to a metallic part. The non-metallic part, consisting of a semi-conducting material, will be easily separable from the insulant in order to facilitate cleaning of the latter. This semi-conducting material will have to constitute a mat which protects the insulant from expansion strains. The metallic part applied over the semi-conducting part will consist of stranded wire with copper tape.

3.3.5 Water Barrier:

The water barrier shall be semi-conducting water swellable tape to be applied over the extruded insulation screening to block and prevent moisture propagation in a longitudinal direction. The semi-conducting tape shall be suitable for the operating temperature of the cable and compatible with the insulation.

3.3.6 Semiconducting Tape

The semiconducting tape(s) should be applied over the insulation screen.

3.3.7 Metallic Screen

The metallic screen shall be plain copper round wires applied helically over the semi-conductor bedding tape(s). The Nos. and Diameter of the copper wire shall be at least (50 X 2.3) sq mm so that the copper screen is able to withstand specified earth fault current. Bidder has to submit the calculations giving details of the area of copper wire screen.

An annealed plain copper binder tape shall be applied in the form of an open helix, over the copper wire screen.

3.3.8 Inner Sheath

For FRLSZH cables an inner layer of FRLSZH tape shall be applied over metallic screen.

3.3.9 Armouring

Double Tape Aluminium armouring should be applied over the inner sheath and the thickness of the same should be as per IEC 60502 as applicable.

3.3.10 Outer Protective Sheath

The anti-corrosion outer protective sheath, applied directly over the metallic screen, whose grade is compatible with the operating temperature of the cables; it must ensure protection against corrosion.

The nominal thickness of this sheath will be determined according to the requirements set forth in standard IEC 60502.

3.4 The cable shall be insulated with XLPE, with semiconducting screen over a copper conducting core and insulating envelope and –

FRLS PVC protective sheath for the cables to be laid outside the underground sections/tunnels. FRLSZH fire retarding protective sheath for the cables to be used inside the tunnel and underground sections.

4. ADDITIONAL REQUIREMENT

4.1 The protective sheath will carry the indications listed below, in letters and digits at least 6 mm high:

- designation of ownership
- nature and cross-sectional area of conductors
- specified cable voltage
- phase numbering
- manufacturer's name

4.2 **Short Circuit Rating of Metallic Sheath/Screen**

The area of plain copper round wire screen shall be designed to meet the requirement of the system short circuit rating of 14 kA for 3 seconds.

4.3 The cables shall pass all the tests stipulated in the IEC standards in force on the date of the order.

4.4 The sleeves and the insulating materials used shall meet the guarantee requirements imposed.

4.5 The equipment shall be capable of withstanding intensive use without alteration, and performing its duty even after extended idle period.

4.6 Atmospheric and Climatic Conditions

The entire equipment will be designed for operation in hot weather, according to the climatic conditions defined in General Specifications.

The equipment will be sturdy and properly treated against corrosion. This protection shall be suited to the various environmental conditions encountered in the various parts of the network.

It must be noted that environmental conditions will be very severe during construction; these conditions shall not be the cause of any alteration of equipment or material whether already installed or simply stored.

5. MAINTENANCE & LIFE

The cable should be designed for maintenance free best service life in the industry and not less than 30 yrs for all types of installation & under prescribed environmental conditions.

6. SPECIAL CONDITIONS

6.1 The manufacturer shall have laid down in-house selection process of the raw material used and shall submit all details, if equivalent raw material is used wherever specified.

6.2 The cable shall be manufactured by a company having ISO accreditation for quality. The manufacturing process of XLPE cable shall consist of conductor screen, insulation & insulation screen which shall be extruded in a single process. (Triple extrusion) and cross linked by a standard Process of dry curing technology to ensure homogeneity and absence of micro voids.

6.3 The Employer may decide to visit the works of cable manufacturer to verify the manufacturing process mentioned.

The Bidder along with the Bid, shall submit the details regarding cable construction, bill of material the manufacturing process proposed to be adopted for the manufacturing of cables to be used in the project, along with Quality control measures adopted by the Manufacturer, to ensure :-

- The values and tolerances are strictly as per IEC.
- The cable manufacturer exercises strict quality control measures, including stage inspections, routine inspections etc. to ensure conformity to standards.

Periodical inspections of the Manufacturer works, manufacturing processes, Internal Quality control records of the manufacturer etc shall be carried out by the User (DMRC/Nominated agency), to ensure compliance to Quality standards.

7. TESTING

7.1 The manufacturer shall submit type test results of 25 kV cable along with vendor approval as per IEC 60840 and shall not be more than 5 years old.

7.2 The 25 kV cable shall comply with following Test Standards in addition to test standards of IEC 60840:

- IEC 60332 Part 1 and 3, category A, test on single and bunched cables under fire condition.
- Limiting Oxygen Index at least 30 tested as per ASTM D-2863.
- Temperature index of minimum 250 deg C as per IS 7098 (Part-2).
- Smoke density Test (on sheathing material), when tested in accordance to ASTM D-2843, maximum smoke density rating shall be 60 as per IS 7098 Part – 2. This will be applicable for FRLS Cable.

- All Insulation is to be moisture and heat resistant, with temperature rating appropriate to the application conditions and in no case lower than 90 deg C.

In addition to the above FRLSZH cables used in Underground section shall also comply with following test standards:-

- Determination of the amount of Halogen Acid Gases as per IEC 60754 Part 1 (Maximum HCL gas shall not exceed 0.5%) and IEC 60754 Part –II
- Smoke density Test (on sheathing material), when tested in accordance to ASTM D-2843, maximum smoke density rating shall be 30. This will be applicable for FRLSZH Cable.

7.3 The user may ask repetition of the following type tests as per IEC 60840 –

- Bending Test
- Tan δ measurement
- Heating Cycle voltage test
- Lightning Impulse voltage followed by a power frequency voltage test
- Partial discharge test
- Examination of the cable system with cable and accessories on completion of above tests.

7.4 The client will deliver the supply, upon request, only after execution of in-plant inspection operations and satisfactory testing according to the technical requirements imposed*.*

7.5 The manufacturer shall not change the Bill of Material used in the manufacturing of samples for routine and Type testing as repeated above and in cables intended to supply against the contract.

8. DATA SHEET- 25KV CABLES

Sl. No.	Description	Unit	Values
1	Manufacturer		
2	Reference Standard		IEC 60840
3	Voltage Grade (U_0/U (U_2)	KV	26/45 (52)
4	Operating Voltage	KV	27.5
5	Cable type		Cu/XLPE
6	Manufacturing Process		Dry Curing
7	Cable Size	Sq mm	240
8.1	Conductor Material		Annealed Copper
8.2	Conductor Diameter	mm	*
9.1	Core Screen		Extruded semi-conducting compound
9.2	Thickness of Core Screen	mm	*
10.1	Insulation		Extruded semi-conducting compound
10.2	Minimum thickness of Insulation	mm	10
11.1	Insulating Envelope screen		Non-metallic part of semi-conducting material plus metallic part consisting of standard wire and copper tape, rated to carry a short circuit current of 14 kA for 3 sec
11.2	Thickness of insulation screen	mm	Bidder to provide
12.1	Outer Sheath	mm	FRLS/FRLSZH as applicable
12.2	Thickness of Outer Sheath	mm	*
13	Nominal overall diameter of Cable	mm	*
14	Approx weight of Cable		*
15	Minimum bending radius	mm	*

***Length marking**: Length shall be marked with number at one meter intervals on the sheath.*

**Bidder to furnish the data at the time of vendor approval or design approval stage.*