

SECTION 7.5

TECHNICAL SPECIFICATION OF POWER/CONTROL CABLES, CONDUCTOR AND CABLE FAULT LOCATOR

7.5.1 Power Cables, Conductor and Control Cables

7.5.1.1 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF 33 KV, 1Cx800 Sq.MM XLPE CU CABLE WITH TERMINATION KIT

The manufacturing process shall be designed to eliminate irregularities like protrusions, voids and contamination etc. to ensure the long-term reliability of the 33kV XLPE Cu cable. The 33kV XLPE Cu cable covered in this specification shall be manufactured by Triple extrusion and Gas curing process ensuring circularity and concentricity of the extruded layers around the conductor and all three layers (conductor screen, XLPE insulation and insulation screen) shall be extruded in simultaneous triple extrusion process. The details of manufacturing process and curing to be adopted shall be mentioned clearly in the offer.

Raw materials used to manufacture the cable shall be of highest quality and it should meet material standards mentioned in IEC 60 502-2. The materials shall be clean and packed in moisture and dust proof packing. Material received by manufacturer should be checked/ tested to ensure that it meets material specification.

Loading of the extruder in the manufacturing plant shall be performed entirely closed and dust proof environment. Contamination shall be avoided by the use of a fully enclosed material handling system. The use of special means like pressurized air etc. for transport of granules, as far as practicable, shall be avoided.

The cross linking, curing and cooling may be carried out in one operation and shall be a gas curing process under high pressure to eliminate the formation of voids in the insulation and contaminants in the dielectric. Process conditions such as curing and cooling temperatures, production speed etc. shall be closely monitored during manufacture to ensure a good degree of cross-linking through the whole insulation.

The cable will be laid in underground in an area with highly moist soil so metal sheath of either lead or aluminium shall be employed to act as moisture barrier layer.

Cable Construction

The 33kV XLPE Cable shall have stranded compacted round copper conductor, taped with semi conducting tapes, conductor screening with extruded semi conducting thermosetting compound, with completely gas cured XLPE insulation, adequate insulation screening consisting of extruded semi conducting thermosetting compound layer, taped with semi conducting water swellable tape, extruded/welded corrugated Aluminium sheathed and overall extruded termite repellent black PE sheathed with outer conducting layer.

Conductor

The conductor shall be stranded compacted round copper conductor complying the requirement of flexibility Class-2 of IEC 60 228. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. The nominal area of conductor shall be 800 sq. mm.

The minimum number of wires in conductor shall be 91 and the maximum DC resistance of conductor shall be 0.0221Ω/KM at 20°C.

Conductor Screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.8 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Insulation

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirement as per IEC 60 502-2. The insulation shall be applied by extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants. The nominal thickness of insulation shall be 8.0 mm.

Insulation Screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation.

The minimum thickness of insulation screen shall be 0.5 mm.

Metallic Screen

The metallic Screen shall consist of a concentric layer of copper wires or a combination of copper wires and helically applied coppertape(s) as per IEC Standard.

The metallic Screen shall be so designed to carry the specified earth fault current of 40KA for 1 second.

Separation Sheath

The Separation Sheath should covering the whole surface area of the metallic screen as per IEC Standard.

Armour

The armour shall be Aluminium Alloy round wires or Corrugated Aluminum sheath as per IEC Standard.

Outer sheath

The outer sheath shall consist of an extruded layer of black medium density polyethylene. The outer sheath shall be of sufficient hardness to discourage termite attacks. The properties of outer sheath material shall be as per IEC 60 840. The nominal thickness of outer sheath shall be 2.8 mm.

Marking on Outer Sheath

The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

- a) Manufacturer’s name and/or trade name.
- b) Voltage grade viz. 33 kV
- c) Cable size (no. of core x conductor cross section).
- d) Year of manufacture.
- e) Purchaser’s name i.e. BPDB.

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm. In case of printed over a tape, the same shall be provided inside the cable.

Straight-through joint box for 33KV XLPE, 1-Core, 800 mm² Copper cable

Item No.	Description of Items	Particulars
I	Application	For 33KV, 1-core, XLPE 800 mm ² Copper Conductors
Ii	Installation	For underground horizontal mounting
Iii	System	33KV, effectively earthed system

Iv	Cable conductor	800 mm ² 1-core, Copper Conductors
V	Construction	The joint shall be proof against ingress of moisture and water
Vi	Kit content	<ul style="list-style-type: none"> - Compression ferrules - Valid filling tape - Heat shrinkable stress control tubing - Truck resistant sealant tape - Heat shrinkable high voltage insulating tape - Heat shrinkable black/red dual wall - Estomeric tube - Roll spring - Heat shrinkable outer jacket tube - Cable preparation kit - Solderless earth connection kit - Misc. other material - Installation instructions

Indoor Termination Kits for 33KV, XLPE, 1-Core, 800 mm² Copper cable

I	Application	For 33KV, 1-core, XLPE 800 mm ² Copper Conductors
ii	Installation	For Indoor switchgear terminations
iii	System	33KV, effectively earthed system
Iv	Cable conductor	800 mm ² 1-core, Copper Conductors
V	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Cable preparation kit - Solderless earth connection kit - Compression lugs for 800 mm² Copper Conductors - Installation instructions

Outdoor Termination Kits for 33KV, XLPE, 1-Core, 800 mm² Copper cable

I	Application	For 33KV, 1-core, XLPE 800 mm ² Copper Conductors
ii	Installation	For outdoor installation on poles/structures
iii	System	33KV, effectively earthed system
iv	Cable conductor	800 mm ² 1-core Copper Conductors
v	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Heat shrinkable truck resistant rain skirt - Support insulator - Cable preparation kit - Solderless earth connection kit - Compression lugs for 800 mm² Copper Conductors - Support insulators Tee Brackets - Installation instructions

7.5.1.2 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF 33 KV, 1Cx500MM2 XLPE CU CABLE WITH TERMINATION KIT

The manufacturing process shall be designed to eliminate irregularities like protrusions, voids and contamination etc. to ensure the long-term reliability of the 33kV XLPE Cu cable. The 33kV XLPE Cu cable covered in this specification shall be manufactured by Triple extrusion and Gas curing process ensuring circularity and concentricity of the extruded layers around the conductor and all three layers (conductor screen, XLPE insulation and insulation screen) shall be extruded in simultaneous triple extrusion process. The details of manufacturing process and curing to be adopted shall be mentioned clearly in the offer.

Raw materials used to manufacture the cable shall be of highest quality and it should meet material standards mentioned in IEC 60502-2. The materials shall be clean and packed in moisture and dust proof packing. Material received by manufacturer should be checked/ tested to ensure that it meets material specification.

Loading of the extruder in the manufacturing plant shall be performed entirely closed and dust proof environment. Contamination shall be avoided by the use of a fully enclosed material handling system. The use of special means like pressurized air etc. for transport of granules, as far as practicable, shall be avoided.

The cross linking, curing and cooling may be carried out in one operation and shall be a gas curing process under high pressure to eliminate the formation of voids in the insulation and contaminants in the dielectric. Process conditions such as curing and cooling temperatures, production speed etc. shall be closely monitored during manufacture to ensure a good degree of cross-linking through the whole insulation.

The cable will be laid in underground in an area with highly moist soil so metal sheath of either lead or aluminium shall be employed to act as moisture barrier layer.

Cable Construction

The 33kV XLPE Cable shall have stranded compacted round copper conductor, taped with semi conducting tapes, conductor screening with extruded semi conducting thermosetting compound, with completely gas cured XLPE insulation, adequate insulation screening consisting of extruded semi conducting thermosetting compound layer, taped with semi conducting water swellable tape, extruded/welded corrugated Aluminium sheathed and overall extruded termite repellent black PE sheathed with outer conducting layer.

Conductor

The conductor shall be stranded compacted round copper conductor complying the requirement of flexibility Class-2 of IEC 60 228. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. The nominal area of conductor shall be 500 sq. mm. The minimum number of wires in conductor shall be 61 and the maximum DC resistance of conductor shall be 0.0366 Ω /KM at 20°C.

Conductor Screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.8 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Insulation

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirement as per IEC 60 502-2. The insulation shall be applied by extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants. The nominal thickness of insulation shall be 8.0 mm.

Insulation Screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation.

The minimum thickness of insulation screen shall be 0.5 mm.

Metallic Screen

The metallic Screen shall consist of a concentric layer of copper wires or a combination of copper wires and helically applied copper tape(s) as per IEC Standard.

The metallic Screen shall be so designed to carry the specified earth fault current of 40KA for 1 second.

Separation Sheath

The Separation Sheath should covering the whole surface area of the metallic screen as per IEC Standard.

Armour

The armour shall be Aluminium Alloy round wires or Corrugated Aluminum sheath as per IEC Standard

Outer sheath

The outer sheath shall consist of an extruded layer of black medium density polyethylene. The outer sheath shall be of sufficient hardness to discourage termite attacks. The properties of outer sheath material shall be as per IEC 60 840. The nominal thickness of outer sheath shall be 2.6 mm.

Marking on Outer Sheath

The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

- f) Manufacturer's name and/or trade name.
- g) Voltage grade viz. 33 kV or 11 kV.
- h) Cable size (no. of core x conductor cross section).
- i) Year of manufacture.
- j) Purchaser's name i.e. BPDB.

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm. In case of printed over a tape, the same shall be provided inside the cable.

Straight-through joint box for 33kV XLPE, 1-Core, 500 mm² Copper cable

Item No.	Description of Items	Particulars
i	Application	For 33KV, 1-core, XLPE 500 mm ² Copper Conductors
ii	Installation	For underground horizontal mounting
iii	System	33KV, effectively earthed system
iv	Cable conductor	500 mm ² 1-core, Copper Conductors
v	Construction	The joint shall be proof against ingress of moisture and water

vi	Kit content	<ul style="list-style-type: none"> - Compression ferrules - Valid filling tape - Heat shrinkable stress control tubing - Truck resistant sealant tape - Heat shrinkable high voltage insulating tape - Heat shrinkable black/red dual wall - Estomeric tube - Roll spring - Heat shrinkable outer jacket tube - Cable preparation kit - Solderless earth connection kit - Misc. other material - Installation instructions
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Indoor Termination Kits for 33kV, XLPE, 1-Core, 500 mm² Copper cable

i	Application	For 33KV, 1-core, XLPE 500 mm ² Copper Conductors
ii	Installation	For Indoor switchgear terminations
iii	System	33KV, effectively earthed system
iv	Cable conductor	500 mm ² 1-core, Copper Conductors
v	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Cable preparation kit - Solderless earth connection kit - Compression lugs for 500 mm² Copper Conductors - Installation instructions

Outdoor Termination Kits for 33kV, XLPE, 1-Core, 500 mm² Copper cable

i	Application	For 33KV, 1-core, XLPE 500 mm ² Copper Conductors
ii	Installation	For outdoor installation on poles/structures
iii	System	33KV, effectively earthed system
iv	Cable conductor	500 mm ² 1-core Copper Conductors
v	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Heat shrinkable truck resistant rain skirt - Support insulator - Cable preparation kit - Solderless earth connection kit - Compression lugs for 500 mm² Copper Conductors - Support insulators Tee Brackets - Installation instructions

7.5.1.3 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF 33 KV, 3Cx95 SQ.MM XLPE CU CABLE WITH TERMINATION KIT

The manufacturing process shall be designed to eliminate irregularities like protrusions, voids and contamination etc. to ensure the long-term reliability of the 33kV XLPE Cu cable. The 33kV XLPE Cu cable covered in this specification shall be manufactured by Triple extrusion and Gas curing process ensuring circularity and concentricity of the extruded layers around the conductor and all three layers (conductor screen, XLPE insulation and insulation screen) shall be extruded in simultaneous triple extrusion process. The details of manufacturing process and curing to be adopted shall be mentioned clearly in the offer.

Raw materials used to manufacture the cable shall be of highest quality and it should meet material standards mentioned in IEC 60 502-2. The materials shall be clean and packed in moisture and dust proof packing. Material received by manufacturer should be checked/ tested to ensure that it meets material specification.

Loading of the extruder in the manufacturing plant shall be performed entirely closed and dust proof environment. Contamination shall be avoided by the use of a fully enclosed material handling system. The use of special means like pressurized air etc. for transport of granules, as far as practicable, shall be avoided.

The cross linking, curing and cooling may be carried out in one operation and shall be a gas curing process under high pressure to eliminate the formation of voids in the insulation and contaminants in the dielectric. Process conditions such as curing and cooling temperatures, production speed etc. shall be closely monitored during manufacture to ensure a good degree of cross-linking through the whole insulation.

The cable will be laid in underground in an area with highly moist soil so metal sheath of either lead or aluminium shall be employed to act as moisture barrier layer.

Cable Construction

The 33kV XLPE Cable shall have stranded compacted round copper conductor, taped with semi conducting tapes, conductor screening with extruded semi conducting thermosetting compound, with completely gas cured XLPE insulation, adequate insulation screening consisting of extruded semi conducting thermosetting compound layer, taped with semi conducting water swellable tape, extruded/welded corrugated Aluminium sheathed and overall extruded termite repellent black PE sheathed with outer conducting layer.

Conductor

The conductor shall be stranded compacted round copper conductor complying the requirement of flexibility Class-2 of IEC 60 228. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. The nominal area of conductor shall be 3X95 sq. mm. The minimum number of wires in conductor shall be 61 and the maximum DC resistance of conductor shall be 0.193Ω/KM at 20°C.

Conductor Screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.8 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Insulation

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirement as per IEC 60 502-2. The insulation shall be applied by extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants. The nominal thickness of insulation shall be 8.0 mm.

Insulation Screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation.

The minimum thickness of insulation screen shall be 0.5 mm.

Metallic Screen

The metallic Screen shall consist of a concentric layer of copper wires or a combination of copper wires and helically applied coppertape(s) as per IEC Standard.

The metallic Screen shall be so designed to carry the specified earth fault current of 40KA for 1 second.

Separation Sheath

The Separation Sheath should covering the whole surface area of the metallic screen as per IEC Standard.

Armour

The armour shall be Aluminium Alloy round wires or Corrugated Aluminum sheath as per IEC Standard.

Outer sheath

The outer sheath shall consist of an extruded layer of black medium density polyethylene. The outer sheath shall be of sufficient hardness to discourage termite attacks. The properties of outer sheath material shall be as per IEC 60 840. The nominal thickness of outer sheath shall be 3.10 mm.

Marking on Outer Sheath

The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

- k) Manufacturer’s name and/or trade name.
- l) Voltage grade viz. 33 kV
- m) Cable size (no. of core x conductor cross section).
- n) Year of manufacture.
- o) Purchaser’s name i.e. BPDB.

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm. In case of printed over a tape, the same shall be provided inside the cable.

Straight-through joint box for 33KV XLPE, 3-Core, 95 mm² Copper cable

Item No.	Description of Items	Particulars
I	Application	For 33KV, 3-core, XLPE 95 mm ² Copper Conductors
Ii	Installation	For underground horizontal mounting
Iii	System	33KV, effectively earthed system
Iv	Cable conductor	95 mm ² 3-core, Copper Conductors
V	Construction	The joint shall be proof against ingress of moisture and water
Vi	Kit content	- Compression ferrules - Valid filling tape

		<ul style="list-style-type: none"> - Heat shrinkable stress control tubing - Truck resistant sealant tape - Heat shrinkable high voltage insulating tape - Heat shrinkable black/red dual wall - Estomeric tube - Roll spring - Heat shrinkable outer jacket tube - Cable preparation kit - Solderless earth connection kit - Misc. other material - Installation instructions
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Indoor Termination Kits for 33KV, XLPE, 3-Core, 95 mm² Copper cable

I	Application	For 33KV, 3-core, XLPE 95mm ² Copper Conductors
ii	Installation	For Indoor switchgear terminations
iii	System	33KV, effectively earthed system
iv	Cable conductor	95 mm ² 3-core, Copper Conductors
V	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Cable preparation kit - Solderless earth connection kit - Compression lugs for 3X95 mm² Copper Conductors - Installation instructions

Outdoor Termination Kits for 33KV, XLPE, 3-Core, 95mm² Copper cable

I	Application	For 33KV, 3-core, XLPE 95 mm ² Copper Conductors
ii	Installation	For outdoor installation on poles/structures
iii	System	33KV, effectively earthed system
iv	Cable conductor	95 mm ² 3-core Copper Conductors
v	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Heat shrinkable truck resistant rain skirt - Support insulator - Cable preparation kit - Solderless earth connection kit - Compression lugs for 3X95 mm² Copper Conductors - Support insulators Tee Brackets - Installation instructions

7.5.1.4 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF 11 KV, 1Cx630 SQ.MM XLPE CU CABLE WITH TERMINATION KIT

The manufacturing process shall be designed to eliminate irregularities like protrusions, voids and contamination etc. to ensure the long-term reliability of the 11kV XLPE Cu cable. The 11kV XLPE Cu cable covered in this specification shall be manufactured by Triple

extrusion and Gas curing process ensuring circularity and concentricity of the extruded layers around the conductor and all three layers (conductor screen, XLPE insulation and insulation screen) shall be extruded in simultaneous triple extrusion process. The details of manufacturing process and curing to be adopted shall be mentioned clearly in the offer.

Raw materials used to manufacture the cable shall be of highest quality and it should meet material standards mentioned in IEC 60 502-2. The materials shall be clean and packed in moisture and dust proof packing. Material received by manufacturer should be checked/ tested to ensure that it meets material specification.

Loading of the extruder in the manufacturing plant shall be performed entirely closed and dust proof environment. Contamination shall be avoided by the use of a fully enclosed material handling system. The use of special means like pressurized air etc. for transport of granules, as far as practicable, shall be avoided.

The cross linking, curing and cooling may be carried out in one operation and shall be a gas curing process under high pressure to eliminate the formation of voids in the insulation and contaminants in the dielectric. Process conditions such as curing and cooling temperatures, production speed etc. shall be closely monitored during manufacture to ensure a good degree of cross-linking through the whole insulation.

The cable will be laid in underground in an area with highly moist soil so metal sheath of either lead or aluminium shall be employed to act as moisture barrier layer.

Cable Construction

The 11kV XLPE Cable shall have stranded compacted round copper conductor, taped with semi conducting tapes, conductor screening with extruded semi conducting thermosetting compound, with completely gas cured XLPE insulation, adequate insulation screening consisting of extruded semi conducting thermosetting compound layer, taped with semi conducting water swellable tape, extruded/welded corrugated Aluminium sheathed and overall extruded termite repellent black PE sheathed with outer conducting layer.

Conductor

The conductor shall be stranded compacted round copper conductor complying the requirement of flexibility Class-2 of IEC 60 228. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. The nominal area of conductor shall be 630 sq. mm. The minimum number of wires in conductor shall be 61 and the maximum DC resistance of conductor shall be 0.0366Ω/KM at 20°C.

Conductor Screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.8 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Insulation

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirement as per IEC 60 502-2. The insulation shall be applied by

extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants. The nominal thickness of insulation shall be 3.8 mm.

Insulation Screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation.

The minimum thickness of insulation screen shall be 0.5 mm.

Metallic Screen

The metallic Screen shall consist of a concentric layer of copper wires or a combination of copper wires and helically applied coppertape(s) as per IEC Standard.

The metallic Screen shall be so designed to carry the specified earth fault current of 25KA for 1 second.

Separation Sheath

The Separation Sheath should covering the whole surface area of the metallic screen as per IEC Standard.

Armour

The armour shall be Aluminium Alloy round wires or Corrugated Aluminum sheath as per IEC Standard.

Outer sheath

The outer sheath shall consist of an extruded layer of black medium density polyethylene. The outer sheath shall be of sufficient hardness to discourage termite attacks. The properties of outer sheath material shall be as per IEC 60 840. The nominal thickness of outer sheath shall be 2.5mm.

Marking on Outer Sheath

The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

- p) Manufacturer’s name and/or trade name.
- q) Voltage grade viz. 11 kV
- r) Cable size (no. of core x conductor cross section).
- s) Year of manufacture.
- t) Purchaser’s name i.e. BPDB.

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm. In case of printed over a tape, the same shall be provided inside the cable.

Straight-through joint box for 11KV XLPE, 1-Core, 630 mm² Copper cable

Item No.	Description of Items	Particulars
I	Application	For 11KV, 1-core, XLPE 630 mm ² Copper Conductors
Ii	Installation	For underground horizontal mounting
Iii	System	11KV, effectively earthed system
Iv	Cable conductor	630 mm ² 1-core, Copper Conductors
V	Construction	The joint shall be proof against ingress of moisture and water
Vi	Kit content	- Compression ferrules - Valid filling tape - Heat shrinkable stress control tubing

		<ul style="list-style-type: none"> - Truck resistant sealant tape - Heat shrinkable high voltage insulating tape - Heat shrinkable black/red dual wall - Estomeric tube - Roll spring - Heat shrinkable outer jacket tube - Cable preparation kit - Solderless earth connection kit - Misc. other material - Installation instructions
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Indoor Termination Kits for 11KV, XLPE, 1-Core, 630 mm² Copper cable

I	Application	For 11KV, 1-core, XLPE 630mm ² Copper Conductors
ii	Installation	For Indoor switchgear terminations
iii	System	11KV, effectively earthed system
iv	Cable conductor	630 mm ² 1-core, Copper Conductors
V	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Cable preparation kit - Solderless earth connection kit - Compression lugs for 630 mm² Copper Conductors - Installation instructions

Outdoor Termination Kits for 11KV, XLPE, 1-Core, 630mm² Copper cable

I	Application	For 11KV, 1-core, XLPE 630 mm ² Copper Conductors
ii	Installation	For outdoor installation on poles/structures
iii	System	11KV, effectively earthed system
iv	Cable conductor	630 mm ² 1-core Copper Conductors
v	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Heat shrinkable truck resistant rain skirt - Support insulator - Cable preparation kit - Solderless earth connection kit - Compression lugs for 630 mm² Copper Conductors - Support insulators Tee Brackets - Installation instructions

7.5.1.5 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF 11 KV, 3Cx185 SQ.MM XLPE CU CABLE WITH TERMINATION KIT

The manufacturing process shall be designed to eliminate irregularities like protrusions, voids and contamination etc. to ensure the long-term reliability of the 11kV XLPE Cu cable. The 11kV XLPE Cu cable covered in this specification shall be manufactured by Triple

extrusion and Gas curing process ensuring circularity and concentricity of the extruded layers around the conductor and all three layers (conductor screen, XLPE insulation and insulation screen) shall be extruded in simultaneous triple extrusion process. The details of manufacturing process and curing to be adopted shall be mentioned clearly in the offer.

Raw materials used to manufacture the cable shall be of highest quality and it should meet material standards mentioned in IEC 60 502-2. The materials shall be clean and packed in moisture and dust proof packing. Material received by manufacturer should be checked/ tested to ensure that it meets material specification.

Loading of the extruder in the manufacturing plant shall be performed entirely closed and dust proof environment. Contamination shall be avoided by the use of a fully enclosed material handling system. The use of special means like pressurized air etc. for transport of granules, as far as practicable, shall be avoided.

The cross linking, curing and cooling may be carried out in one operation and shall be a gas curing process under high pressure to eliminate the formation of voids in the insulation and contaminants in the dielectric. Process conditions such as curing and cooling temperatures, production speed etc. shall be closely monitored during manufacture to ensure a good degree of cross-linking through the whole insulation.

The cable will be laid in underground in an area with highly moist soil so metal sheath of either lead or aluminium shall be employed to act as moisture barrier layer.

Cable Construction

The 11kV XLPE Cable shall have stranded compacted round copper conductor, taped with semi conducting tapes, conductor screening with extruded semi conducting thermosetting compound, with completely gas cured XLPE insulation, adequate insulation screening consisting of extruded semi conducting thermosetting compound layer, taped with semi conducting water swellable tape, extruded/welded corrugated Aluminium sheathed and overall extruded termite repellent black PE sheathed with outer conducting layer.

Conductor

The conductor shall be stranded compacted round copper conductor complying the requirement of flexibility Class-2 of IEC 60 228. The wires shall be made of high conductivity copper and shall be stranded mid compacted. The copper used for the conductor shall be of highest purity. The nominal area of conductor shall be 3X185 sq. mm. The minimum number of wires in conductor shall be 61 and the maximum DC resistance of conductor shall be 0.0991Ω/KM at 20°C.

Conductor Screen

The conductor screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface of the conductor. The screen shall be firmly bonded to XLPE insulation. The minimum thickness of conductor screen shall be 0.5 mm. (approx.)

A non-hygroscopic semi conducting tape may be applied over the conductor surface under extruded layer. The outer surface of the conductor screen shall be circular and free from irregularities.

Insulation

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirement as per IEC 60 502-2. The insulation shall be applied by extrusion and vulcanisation to form a compact homogenous body free from micro voids and contaminants. The nominal thickness of insulation shall be 3.4 mm.

Insulation Screen

The insulation screen shall consist of an extruded layer of thermosetting semi conducting compound and shall be continuous and cover the whole surface area of insulation. It shall be firmly bonded to the insulation.

The minimum thickness of insulation screen shall be 0.5 mm.

Metallic Screen

The metallic Screen shall consist of a concentric layer of copper wires or a combination of copper wires and helically applied coppertape(s) as per IEC Standard.

The metallic Screen shall be so designed to carry the specified earth fault current of 25KA for 1 second.

Separation Sheath

The Separation Sheath should covering the whole surface area of the metallic screen as per IEC Standard.

Armour

The armour shall be Aluminium Alloy round wires or Corrugated Aluminum sheath as per IEC Standard.

Outer sheath

The outer sheath shall consist of an extruded layer of black medium density polyethylene. The outer sheath shall be of sufficient hardness to discourage termite attacks. The properties of outer sheath material shall be as per IEC 60 840. The nominal thickness of outer sheath shall be 3.1mm.

Marking on Outer Sheath

The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

- u) Manufacturer's name and/or trade name.
- v) Voltage grade viz. 11 kV
- w) Cable size (no. of core x conductor cross section).
- x) Year of manufacture.
- y) Purchaser's name i.e. BPDB.

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm. In case of printed over a tape, the same shall be provided inside the cable.

Straight-through joint box for 11KV XLPE, 3-Core, 185 mm² Copper cable

Item No.	Description of Items	Particulars
I	Application	For 11KV, 3-core, XLPE 185 mm ² Copper Conductors
Ii	Installation	For underground horizontal mounting
Iii	System	11KV, effectively earthed system
Iv	Cable conductor	185 mm ² 3-core, Copper Conductors
V	Construction	The joint shall be proof against ingress of moisture and water
Vi	Kit content	<ul style="list-style-type: none"> - Compression ferrules - Valid filling tape - Heat shrinkable stress control tubing - Truck resistant sealant tape - Heat shrinkable high voltage insulating tape - Heat shrinkable black/red dual wall

		<ul style="list-style-type: none"> - Estomeric tube - Roll spring - Heat shrinkable outer jacket tube - Cable preparation kit - Solderless earth connection kit - Misc. other material - Installation instructions
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Indoor Termination Kits for 11KV, XLPE, 3-Core, 185mm² Copper cable

I	Application	For 11KV, 3-core, XLPE 185mm ² Copper Conductors
ii	Installation	For Indoor switchgear terminations
iii	System	11KV, effectively earthed system
Iv	Cable conductor	185 mm ² 3-core, Copper Conductors
V	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Cable preparation kit - Solderless earth connection kit - Compression lugs for 3x185 mm² Copper Conductors - Installation instructions

Outdoor Termination Kits for 11KV, XLPE, 3-Core, 185mm² Copper cable

I	Application	For 11KV, 3-core, XLPE 185 mm ² Copper Conductors
ii	Installation	For outdoor installation on poles/structures
iii	System	11KV, effectively earthed system
iv	Cable conductor	185 mm ² 3-core Copper Conductors
v	Kit content	<ul style="list-style-type: none"> - Heat shrinkable high voltage insulating and non-tracking tubing - Heat shrinkable stress control tubing - Stress relieving mastic strip - Truck resistant sealant tape - Heat shrinkable truck resistant rain skirt - Support insulator - Cable preparation kit - Solderless earth connection kit - Compression lugs for 3X180 mm² Copper Conductors - Support insulators Tee Brackets - Installation instructions

7.5.1.6 Tests for All 33kV & 11kV XLPE Power Cables .

All type, routine and acceptance (special) tests shall be carried out as per IEC 60 502-2. The manufacturer of cable must have at least ISO 9001 certified quality Assurance system in their manufacturing system.

Routine Tests

The following routine tests shall be carried out on each manufactured length

- a) Partial discharge test
- b) Voltage test
- c) DC voltage test on outer sheath
- d) Conductor resistance test

Special (Acceptance) Tests

The following tests shall be made on samples which, for the tests in items (b) and (g), may be on complete drum length of cable taken to represent batches

- a) Conductor examination
- b) Measurement of electrical resistance of conductor
- c) Measurement of thickness of insulation and non-metallic sheath
- d) Measurement of thickness of metallic sheath
- e) Measurement of overall cable diameter
- f) Hot set test for XLPE insulation
- g) Measurement of capacitance

Frequency of Tests

The above special (acceptance) tests shall be made on one length from each manufacturing series of the same type size of cable, but shall be limited to not more than 10% of the number of lengths in any contract, rounded to upper unity.

Type Tests

The following tests shall be included in the type tests (Electrical) Tests.

- a) Bending test followed by Partial discharge test
- b) Tan δ measurement
- c) Heating cycle test followed by partial discharge measurement
- d) Impulse withstand test followed by a power frequency voltage test

Test on cable components

- a) Check for cable construction
- b) Resistivity of semi conducting layers
- c) Test for determining the mechanical properties of insulation before and after ageing
- d) Test for determining the mechanical properties of non-metallic sheath before and after ageing.
- e) Ageing tests on pieces of complete cable to check compatibility of materials
- f) Pressure test at high temperature on sheath
- g) Hot set test on XLPE insulation
- h) Carbon black content of PE sheath
- i) Shrinkage test on XLPE insulation.

7.5.1.7 Technical Orientation and Quality Test Witness of XLPE Power cable:

The Purchaser shall have the right to inspect/test the goods/materials to confirm their conformity to the specification. The purchaser shall be entitled at all reasonable time during manufacture to inspect, examine and test of goods/materials at the manufacturers' premises, workmanship and performance.

At least the following test along with routine test shall be carried out as per latest version of IEC Standard or equivalent IEEE standard or BS standard unless otherwise mentioned at the manufacturer premises or other places where the test facilities are available:-

1. Measurement of Electrical Resistance of conducts.
2. High voltage test
3. Partial discharge test
4. Capacitance test
5. Voltage test on cable serving
6. Measurement of dimension of insulation and conductor

The Supplier shall, after consulting the purchaser, give the Purchaser reasonable notice in writing of the date on and the place at which any material or equipment will be ready for testing as

provided in the contract and unless the purchaser shall attend at the place so named on date, which the supplier has stated in his notice, the supplier may proceed with the tests, which shall be deemed to have been made in the purchaser's presence, and shall forth with forward to the purchaser duly certified copies of test readings.

When the purchaser intends to attend the test he shall promptly inform the supplier accordingly in writing, so that he can take action. The purchaser shall give the supplier timely notice in writing of his intention to attend the test. The contractor shall submit the factory test report to the engineer for check and verification at least 15 days prior to inspection.

Where the supplier provides for tests on the premises of the supplier or of any manufacturer of the supplier, except where otherwise specified, shall provide free of charge such assistance, labor, materials, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such test efficiently. These test shall be performed as per relevant IEC Standard or equivalent IEEE standard or BS standard only routine tests as agreed upon, will be performed.

As and when the purchaser is satisfied that any materials/equipment shall have passes the tests referred to in this clause, purchaser shall notify the contractor in writing to that effect. Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the item or complete batch if necessary. In that case Supplier have to replace the Equipment and to make good of them without any financial involvement to the Purchaser. In case any of the Equipment found not conforming with the specification at the time of post landing Inspection, the supplier will in no way be relieved from the responsibility of replacing them on making them good at their own cost, despite the Equipment were found good at the time of Factory Acceptance Test. Nothing in this clause shall in any way release the supplier from any warranty or other obligations under the contract.

7.5.1.8 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF 0.4 kV, 4x120 mm² PVC Copper Cable

GENERAL SPECIFICATIONS

These single core cables shall be designed as per above standards and suitable for operation at a maximum voltage of 1000V line to line and suitable for use underground buried in earth or in ducts and above ground in air or in buildings under local ambient conditions.

The maximum acceptable length of cable on a drum shall be 500M and shall be supplied on standard non-returnable treated wooden drum, each drum having stenciled on each side: drum number, code name of conductor, drum wound length together with gross and net weight, the manufacturer name, the purchaser's name and contract number with date. The cover of the drum should be of same treated wood.

Cable construction shall be as per BS 6004:1994 or equivalent to any internationally acceptable standard. Conductors shall be circular plain annealed copper in accordance with IEC 60228. Thickness of insulation shall be in accordance with IEC 502-1. The over sheath shall be an external layer of black PVC.

A means of identifying the cable size and BPDB ownership shall be inscribed throughout the length of the Cable in a single line on the PVC Insulation. The letters shall be upright block characters embossed on the surface; they are being not more than 300 mm between each group. The manufacturer's name with year of manufacture and Progressive Meter Marking shall be provided throughout the length of the cable.

Drum wound length of each drum may vary up to $\pm 5\%$ of the total drum length as tolerance. However, the sum of total drum length shall be as per ordered quantity. Only one short length of

conductor on a drum is considered for acceptance, if necessary. For the other requirements, the given data shall be considered as minimum and maximum where necessary. No negative tolerances for the diameter and thickness are acceptable.

Description	Unit	Requirements
Cable Size	mm ²	4CX120
Material		PVC Insulated plain annealed copper.
Numbers & Diameter of wires	No/mm	30/To be mention
Maximum resistance at 30 °C	Ω/KM	0.1010
Nominal thickness of insulation	Mm	2.0
Nominal thickness of sheath	Mm	2.8
Co lour of sheath		Black
Approximate outer diameter	Mm	56.30
Approximate weight	Kg/KM	8725
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	330
Current rating at 35 °C ambient in air	Amps	350

FEATURES AND ACCESSORIES:

- Conductors shall be delivered on standard non-returnable strong wooden drum. The central hole of the drum shall be reinforced to fit on axle size 95 mm diameter. The interior of the conductor drum shall be lined with bituminous paper to prevent the conductor from being in contact with timber or Aluminium water proof paper and felt lining shall overlap at seams by at least 20 mm and the seams shall be sealed.
- Drum shall be adequately protected by securely fastening substantial wooden battens around the periphery. These battens shall be secured by means of hoop metal bindings. Conductor drum shall be treated in an approved manner to resist termite and fungus attacks and shall be suitable for outside storage for a minimum period of 3 years in an equatorial climate without undue deterioration.
- The PVC covering shall be complete with PVC/A for Insulation and PVC-ST2 for Sheath as per requirement of IEC60502-1.
- There shall be only one length of conductor on a drum.
- Treated wooden drum standard: AWPA C₁ – 82, C₂ –83, C₁₆ –82, P₅ –83.

INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for offered cable.
- b) Cross-sectional drawings of offered cable.
- c) Detail description of testing facilities (Routine & Type Test) at manufacturer's plant.

7.5.1.9 SPECIFICATION FOR COPPER CONTROL CABLE

7.5.1.10 STANDARDS:

The cable as specified in this Section shall be conforming to the latest edition of the following standards for operation under local ambient conditions. Design, Manufacture, Testing and Performance of the cable shall be in accordance with the IEC 502-1, BS 6004:1994 or equivalent International standards.

7.5.1.11 SPECIFICATIONS:

These cables shall be designed as per above standards and suitable for operation at a maximum voltage of 1000V line to line and suitable for use underground buried in earth or in ducts and above ground in air or in buildings under local ambient conditions.

The maximum acceptable length of cable on a drum shall be 1000M and shall be supplied on standard non-returnable treated wooden drum, each drum having stencilled on each side, drum number, code name of conductor, drum wound length together with gross and net weight, the manufacturer name, the purchaser's name and contract number with date. The cover of the drum should be of same treated wood.

Cable construction shall be as per BS 6004:1994 or equivalent to any internationally acceptable standard. Thickness of PVC insulation shall be in accordance with IEC 502-1. The over sheath shall be an external layer of black PVC.

A mean of identifying the cable size and BPDB ownership shall be inscribed throughout the length of the Cable in a single line on the PVC Insulation. The letters shall be upright block characters embossed on the surface; they are being not more than 300 mm between each group. The manufacturer's name shall be provided throughout the length of the cable with year of manufacture.

Drum wound length of each drum may vary up to $\pm 5\%$ of the total drum length as tolerance. However, the sum of total drum length shall be as per ordered quantity. Only one short length of conductor on a drum is considered for acceptance, if necessary. For the other requirements, the given data shall be considered as minimum and maximum where necessary. No negative tolerances for the diameter and thickness are acceptable.

Description	Unit	Requirements					
		4CX2.5 mm ²	4CX4mm ²	4CX6mm ²	8CX2.5 mm ²	16CX2.5 mm ²	24CX2.5 mm ²
Cable Size	mm ²	4CX2.5 mm ²	4CX4mm ²	4CX6mm ²	8CX2.5 mm ²	16CX2.5 mm ²	24CX2.5 mm ²
Material		plain annealed copper	plain annealed copper	plain annealed copper	plain annealed copper	plain annealed copper	plain annealed copper
Numbers & Diameter of wires	No/m m	7/0.67	7/0.85	7/1.04	7/0.67	7/0.67	7/0.67
Diameter of Steel wires/ Strips	mm	1.4	4x0.8	4x0.8	4x0.8	4x0.8	4x0.8
Thickness of Steel Tape	mm	-	0.25	0.25	0.25	0.25	0.25
Maximum resistance at 30 °C	Ω/KM	7.28	3.20	3.20	7.69	7.69	7.69
Nominal thickness of PVC insulation	mm	0.8 (min.)	1.0 (min.)	1.0 (min.)	0.8 (min.)	0.8 (min.)	0.8 (min.)
Nominal thickness of PVC sheath	mm	1.8 (min.)	1.8 (min.)	1.8 (min.)	1.8 (min.)	1.8 (min.)	1.8 (min.)
Co lour of sheath		Black	Black	Black	Black	Black	Black
Approximate	mm	17	20	21	20	25	28

outer diameter							
Approximate weight	Kg/K M	670	810	920	1040	1630	1730
Continuous permissible service voltage	V	600/1000	600/1000	600/1000	600/1000	600/1000	600/1000

7.5.1.12 FEATURES AND ACCESSORIES:

- Cables shall be delivered on standard non-returnable strong wooden drum. The central hole of the drum shall be reinforced to fit on axle size 95 mm diameters. The interior of the conductor drum shall be lined with bituminous paper to prevent the conductor from being in contact with timber or Aluminum water proof paper and felt lining shall overlap at seams by at least 20 mm and the seams shall be sealed.
- Drum shall be adequately protected by securely fastening substantial wooden battens around the periphery. These battens shall be secured by means of hoop metal bindings. Conductor drum shall be treated in an approved manner to resist termite and fungus attacks and shall be suitable for outside storage for a minimum period of 3 years in an equatorial climate without undue deterioration.
- There shall be only one length of cable on a drum.
- Treated wooden drum standard: AWPA C₁ - 82, C₂ -83, C₁₆ -82, P₅ -83.

7.5.1.13 INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for offered cable.
- b) Cross-sectional drawings of offered cable.
- c) Detail description of testing facilities (Routine & Type Test) at manufacturer's plant.
- d) Manufacturer's valid ISO 9001 Certificate.

7.5.1.14 TECHNICAL SPECIFICATIONS/REQUIREMENTS OF All Control Cable XLPE Insulated Armoured Copper Cable

7.5.1.15 STANDARDS:

The cable as specified in this Section shall be conforming to the latest edition of the following standards for operation under local ambient conditions. Design, Manufacture, Testing and Performance of the cable shall be in accordance with the IEC 502-1, IEC 60228, BS 6004:1994 or equivalent International standards.

7.5.1.16 SPECIFICATIONS:

These All Control cables shall be designed as per above standards and suitable for operation at a maximum voltage of 1000V line to line and suitable for use underground buried in earth or in ducts and above ground in air or in buildings under local ambient conditions.

The acceptable length of cable on a drum shall be 1000M and shall be supplied on standard non-returnable treated wooden drum, each drum having stenciled on each side : drum number, code name of conductor, drum wound length together with gross and net weight, the manufacturer name, the purchaser's name and contract number with date. The cover of the drum should be of same treated wood.

Cable construction shall be as per BS 6004:1994 or equivalent to any internationally acceptable standard. Conductors shall be circular plain annealed copper in accordance with

IEC 60228. The armoured shall be round Aluminium Wire. Thickness of insulation shall be in accordance with IEC 502-1. The over sheath shall be an external layer of black PVC.

A means of identifying the cable size and BPDB ownership shall be inscribed throughout the length of the Cable in a single line on the PVC Insulation. The letters shall be upright block characters embossed on the surface; they are being not more than 300 mm between each group. The manufacturer's name with year of manufacture and Progressive Meter Marking shall be provided throughout the length of the cable.

The insulation shall be cross-linked polyethylene (XLPE). The insulation material shall comply with the requirements as per IEC-60502-2. The insulation shall be applied by extrusion and vulcanization to form a compact homogeneous body free from micro voids and contaminates.

7.5.1.17 FEATURES AND ACCESSORIES:

- Conductors shall be delivered on standard non-returnable strong wooden drum. The central hole of the drum shall be reinforced to fit on axle size 95 mm diameter. The interior of the conductor drum shall be lined with bituminous paper to prevent the conductor from being in contact with timber or Aluminium water proof paper and felt lining shall overlap at seams by at least 20 mm and the seams shall be sealed.
- Drum shall be adequately protected by securely fastening substantial wooden battens around the periphery. These battens shall be secured by means of hoop metal bindings. Conductor drum shall be treated in an approved manner to resist termite and fungus attacks and shall be suitable for outside storage for a minimum period of 3 years in an equatorial climate with out undue deterioration.
- The PVC covering shall be complete with PVC/A for Insulation and PVC-ST2 for Sheath as per requirement of IEC60502-1.
- There shall be only one length of conductor on a drum.
- Treated wooden drum standard: AWPA C₁ – 82, C₂ –83, C₁₆ –82, P₅ –83.

7.5.1.18 INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for offered cable.
- b) Cross-sectional drawings of offered cable.
- c) Detail description of testing facilities (Routine & Type Test) at manufacturer's plant.
- d) Manufacturer's valid ISO 9001 Certificate.

7.5.1.19 Type Test

Type Test Reports for XLPE Insulated and PVC sheathed Copper cable (4CX4mm²) from an independent testing Laboratory/ Institute as per relevant Standards (unless otherwise specified).

7.5.1.20 Marking on Outer Sheath

The following particulars shall be either marked on Cable outer sheath or printed over a tape at suitable regular intervals.

- z) Manufacturer's name and/or trade name.
- aa) Cable size (no. of core x conductor cross section).
- bb) Year of manufacture.
- cc) Purchaser's name i.e. BPDB.
- dd) Meter Marking (PVC cable should carry a meter mark)

The spacing between one set of marking and lie beginning of the next on the legend shall not exceed 300 mm.

In case of printed over a tape, the same shall be provided inside the cable.
Note: No negative tolerances for the diameter and thickness are acceptable

4CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm ²	4CX2.5mm²
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	3.20
Nominal thickness of insulation	mm	0.80
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	18
Approximate weight	Kg/KM	670
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	34
Current rating at 35 °C ambient in air	Amps	31

4CX4mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm ²	4CX4mm²
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.85
Maximum resistance at 20 °C	Ω/KM	4.61
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	18.4
Approximate weight	Kg/KM	720
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	34
Current rating at 35 °C ambient in air	Amps	31

4CX6mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm ²	4CX6mm²
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/1.04

Maximum resistance at 20 °C	Ω/KM	3.08
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	19.80
Approximate weight	Kg/KM	860
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	64
Current rating at 35 °C ambient in air	Amps	56

8CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm ²	8CX2.5mm²
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	7.69
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	20
Approximate weight	Kg/KM	1040
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	64
Current rating at 35 °C ambient in air	Amps	56

16CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm ²	16CX2.5mm²
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	7.41
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	25.00
Approximate weight	Kg/KM	1260
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient	Amps	15

temperature U/G		
Current rating at 35 °C ambient in air	Amps	12

24CX2.5mm² XLPE Insulated Armoured Copper Cable

Description	Unit	Requirements
Cable Size	mm ²	16CX2.5mm ²
Material		XLPE Insulated and PVC sheathed Armoured Copper Cable
Numbers & Diameter of wires	No/mm	7/0.67
Maximum resistance at 20 °C	Ω/KM	7.69
Nominal thickness of insulation	mm	0.70
Nominal thickness of sheath	mm	1.8
Co lour of sheath		Black
Approximate outer diameter	mm	28.00
Approximate weight	Kg/KM	1730
Continuous permissible service voltage	V	600/1000
Current rating at 30 °C ambient temperature U/G	Amps	15
Current rating at 35 °C ambient in air	Amps	12

7.5.2 INSTALLATION OF 33KV UNDERGROUND CABLE DOUBLE CIRCUIT SOURCE LINE

ROUTE SURVEY

The successful contractor shall make a detailed survey of the cable route after the award of contract to decide the requirements of the following:

Cable delivery length per drum, location of joint bay position. Quantity of joints required. Design of cable laying- directly buried/cables in ducts/pipes for road, communication circuit, gas line, drainage etc. crossing.

LAYING AND INSTALLATION

The bidder is advised to visit the site and acquaint themselves with the topography, infrastructure etc. The contractor shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the erection and successful commissioning of 33kV 1Cx800mm² XLPE cables in all respects.

Cables shall be laid in the trench in buried condition throughout the route except the rail/road/highway/canal, etc. crossing, where ducts of HDPE/MPP/GI pipes to be used. Further, as per requirement of the field, the cables shall also have to be laid in the followings (with prior approval of employer):

- a. In ducts/GI pipes/Hume pipes
- b. In HDPE/MPP pipes (pipes to be filled with sand/suitable material after cabling)
- c. In air at terminations
- d. At varying depths due to obstructions
- e. As per approved drawings

At places where the cables cross private roads, gates of residential houses or buildings, the cables shall be laid in HDPE pipes of adequate strength.

Concrete trenches with precast covers shall be used in all cases, except for cables through HDD. Cables shall be installed by direct burial at an average depth of 1.5 meter from finished ground level. Construction of trench for cable shall also include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of concrete protective covers back filling and compacting supply and installation of route marker and joint marker. Back filling shall be by the material excavated. However, bigger stones and pieces of rock etc. shall be removed. Concrete protective covers (RCC slabs) shall be installed/provided directly over the compacted thermally stable sand over the cable surface, RCC slabs shall sufficiently cover the width of all the cables. Thermal resistivity of sand shall be verified and inspected before the source approval.

The arrangement of laying the cable en-route shall be submitted by contractor during detailed engineering for Employer's acceptance. Similarly, Cable length/schedule, type, joints, joint type, terminations shall be approved by the Employer.

TRENCHING

The cable trench work involves earth excavation for cable trench, back filling and removal of excess earth from site. The work site shall be left as clean as possible.

The trench shall be excavated using manual /mechanical modes as per field conditions. Most main roads are of asphalt surface and some of the roads with cement concrete surface. The sides of the excavated trenches shall wherever required, be well shored up.

Where paved footpaths are encountered, the pavement slabs shall be properly stored and reinstated. Identification markers of other services shall be properly stored and restored. The excavated material shall be properly stored to avoid obstruction to public and traffic movement.

Suitable barriers should be erected between the cable trench and pedestrian/ motorway to prevent accidents. The barriers shall be painted with yellow and black or red and white coloured cross stripes. Warning and caution boards should be consciously displayed. Red lights as warning signal should be placed along the trench during the nights.

The bottom of the excavated trench should be levelled flat and free from any object which would damage the cables. Any gradient encountered shall be gradual.

TREFOIL/FLAT FORMATION

Cables shall be laid in trefoil/flat formation for entire route. The contractor shall submit drawings and arrangements for Employer approval.

CABLE HANDLING

The inspection of cable on receipt, handling of cables, paying out, flaking, cushioning with sand or sieved compacted soil, back-filling, reinstatement of road surfaces, providing and fixing joint markers, route indicators, precautions of joint holes, sump holes and all necessary precautions that are required shall be carefully planned and in accordance with acceptable standard practices/statutory requirements.

DAMAGE TO PROPERTY

The contractor shall take all precautions while excavation of trench, trial pits etc., to protect the public and private properties and to avoid accidental damage. Any damage so caused shall be immediately repaired and brought to the notice of the concerned and to the Employer. The

contractor shall bear all responsibilities and liabilities and shall bear all costs of the damages so caused by him or by his workman or agents.

CABLE ROUTE MARKERS/CABLE JOINT MARKERS

Permanent means of indicating the position of joints and cable route shall be fabricated supplied and erected as per approved drawings.

Markers provided shall be as per the field requirement, if the route passes through open fields, markers should be conspicuously visible and above ground surface.

The marker should incorporate the relevant information such that the name of the Employer, voltage, circuit and distance of cable from the marker.

DEPTH OF LAYING OF CABLES

Depth of laying shall be as per drawing enclosed in Section 9.0. Laying at varying depths due to obstructions/site conditions may be accepted in extreme cases with prior approval of Employer during detailed engineering.

PAYING OUT THE CABLE

The excavated cable trench shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paying out the cable. The cable shall be rolled in the trench on cable rollers, spaced out at uniform intervals. The paying out process must be smooth and steady without subjecting the cable to abnormal tension. The cable on being paid out shall be smoothly and evenly transferred to the ground after providing the cushion. The cables shall never be dropped. All snake bends shall be straightened. Suitable size cable stocking pulling eye shall be used for pulling the cable. While pulling the cable by winches or machines, the tension/ loading shall be monitored by tension indicator and shall not exceed the permissible value for the cable. The cable laying shall be performed continuously at a speed as recommended by manufacturer.

The cable end seals shall be checked after laying and if found damaged shall immediately be resealed. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores for testing and jointing work. The integrity of the outer sheath shall be checked after the cable is laid in position.

SAND BEDDING

The cable shall be completely surrounded by well-compacted cable thermally stable sand to such a thickness and of such size that the cable is protected against damage (applicable where cables are not to be laid in pipes).

SLAKING

Slaking shall be done at necessary places recommended by manufacturer with prior approval of Employer.

BACK FILLING

Normally back filling shall consist of the material earlier excavated. However, bigger stones or pieces of rock should be removed.

WARNING TAPE

A pre-warning, Red colour plastic/ PVC tape, of at least 250 mm wide 100 microns thick, shall be laid at approx. 0.4 m above the cable specified depth, throughout the cable route. The tape shall carry the legend printed in black continuously as under CAUTION; EMPLOYER, VOLTAGE CLASS OF CABLES.

PREVENTION OF DAMAGE DUE TO SHARP EDGES

After the cables have been laid in the trench and until the cables are covered with protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench. Straight and curved rollers used shall have no sharp projecting parts liable to damage the cable. While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges. The cables shall never be bent, beyond the specified bending radius.

ROAD, RAIL & CANAL CROSSINGS

The road cutting, whether cement concrete asphalt or macadam road surface; Railway track crossing and canal crossing shall be taken after obtaining approval for cutting/crossing from the concerned authorities i.e. civic authorities, traffic police, telephone authorities, water/gas supply authorities Railway authorities, Irrigation department etc., and work should be planned to be completed in the shortest possible time. Where necessary the work shall be planned during night or light traffic periods. HDPE/MPP pipes shall be used for crossing. HDPE pipes diameter should not be less than 1.5 times the cable diameter.

TRENCHLESS DIGGING

It is envisaged that trenchless digging shall be used for crossing the National highways, Railway tracks and Canals etc. and the same shall be in the scope of bidder. Trenchless digging shall also be used where the concerned authorities do not permit open cut method and it is essentially required to carry out for installation of underground cables. The trenchless digging methods shall generally conform to relevant standard. The various methods of trenchless digging such as hand/ manual auguring (up to 15m), impact moling (from 16m to about 40-50m), HDD (above 40-50m) shall be adopted based on the soil/site conditions and the requirement. The exact method for trenchless digging shall be finalised during detail engineering as per actual site/soil condition. The equipment used for HDD shall be capable of drilling at least 100m at one go. The contractor shall propose the exact methods and procedures for implementation of trenchless digging at various crossings taking into consideration the following guidelines, for approval by the Employer.

- a) Excavation and backfilling of trial pits and verification of soil condition
- b) Excavation of entry and Exit pits
- c) Erection of drill machine for Drilling of pilot hole
- d) Placement and driving hand augur
- e) Placement and carrying out impact moling
- f) Reaming and widening of bore holes in steps (if required)
- g) Pulling of product pipe

FOOTPATH CUTTING

The slabs, kerbstones, on the roads shall be removed and reinstated without damage.

REINSTATEMENT

After the cables and pipes have been laid and before the trench is backfilled all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the Engineer in charge. The protective covers shall then be provided, the excavated soil riddled, sieved and replaced. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the centre and tapering towards the sides of the trench.

The temporary reinstatement of roadways should be inspected at regular intervals, more frequently in rainy season and immediately after overnight rain for checking settlement and if required the temporary reinstatement should be done.

After the subsidence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

TOOLS AND PLANTS

The successful bidder shall arrange, at his own cost, all necessary tools, plant and equipment to carry out the survey and cable installation work. The bidders are instructed to give all the details of equipment at their disposal, to carry out the work successfully and speedily.

BENDING RADIUS

The minimum bending radius of XLPE insulated cables shall be as per guaranteed technical particulars provided by the cable manufacturer.

JOINTING AND TERMINATION OF CABLES

The cable jointing personnel and his crew shall have good experience in the type of joints and terminations that are used. The jointing work shall commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory-plumbed caps/ seals on the cable ends, and the cable end shall be sealed whenever the end is exposed for tests.

Jointing of cables in carriage ways, drive ways under costly pavings, under concrete or asphalt surfaces and in proximity to telephone cables and water mains should be avoided whenever possible. Sufficient over lap of cables shall be allowed for making the joints.

The joint bay should be of sufficient dimensions to allow the jointers to work with as much freedom of movement and comfort as possible. Sufficient space should be kept below the cable to be jointed. The joints of different phases shall be staggered in the jointing bay.

SUMPHOLES

When jointing cables in water logged ground or under unforeseen rainy conditions, a sump hole should be made at one end of the joint bay, in such a position so that the accumulated water can be pumped or baled out by buckets, without causing interference to the jointing operation.

TENTS/COVERS

An enclosure or suitable protection cover shall be used in all circumstances wherever jointing work is carried out in the open, irrespective of the weather conditions. The joint shall be made in dust free, moisture free and clean atmosphere.

PRECAUTIONS BEFORE MAKING A JOINT

The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/ inclement weather conditions, which might become uncontrollable.

If the cable end seals or cable ends are found to have suffered damage the cables should not be jointed, without tests and rectification.

MEASUREMENT OF INSULATION RESISTANCE

Before jointing, the insulation resistance of both sections of cables shall be checked.

IDENTIFICATION

The identification of each phase, shall be clearly and properly noted. The cables shall be jointed as per the approved design. Each cable shall have identification for phase at joint bays.

MAKING A JOINT

Comprehensive jointing instructions should be obtained from the manufacture of jointing kits and meticulously followed.

The materials used in the joints like ferrules, screen/sheath continuity bonds, lugs etc., shall be of good quality and conform to standards.

The jointing tools shall be appropriate and as per the requirement of jointing HV XLPE cables.

CABLE LAYING & TERMINATIONS

The preparation of the cable end for installing the terminations and the precautions to be taken before fixing the terminations shall be followed as in the case of the cable jointing procedures. The instructions furnished by the termination manufacturer shall be strictly followed.

At cable terminating end, the following provisions for supply and erections are to be included:

- (i) A sufficient length of spare cable shall be left in the ground, for future needs.
- (ii) The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.
- (iii) The cable shall be properly fastened using non-metallic clamps.
- (iv) Appropriate labels shall be fixed identifying the phase circuit, voltage and date of commissioning etc., on the cable supporting structure.
- (v) The sealing end shall be mounted on pedestal insulators to isolate them from their supporting steel work.
- (vi) Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fibre shroud.
- (vii) Providing earth stations with all required materials, like leads, connectors etc. Earth pits shall conform to the latest International standards.

BONDING OF SCREEN/ SHEATH

The screens/sheath shall be cross-bonded under each segment of specified route in accordance with relevant IEC standard or applicable International codes & practices. The bidder shall offer complete cable system in order to limit maximum sheath voltage in accordance with relevant standards and furnish complete set of calculations in support of the same. The screen/sheath shall be connected to the earth stations/ earth pits through disconnecting type link boxes & through Sheath Voltage Limiter (SVL) as required.

All required materials used in the Cross bonding, termination of earth continuity cable, Link box, SVL etc. to comply with specification/statutory requirements shall be in the scope of bidder and should be of good quality and compatible with the cable.

CONNECTION OF RADIAL WATER BARRIER AND CABLE SCREEN

If the metallic radial water barrier is insulated from the metallic wire screen, a connection suitable to carry the currents occurring during operation must be installed between metallic radial water barrier of the cable and metallic wire screen in joints and sealing ends.

CABLE TERMINATING STRUCTURES

The terminating structure being supplied, should be designed as per the project requirement for the cable end terminations i.e. for GIS end terminations as per requirement specified in BPS.

The mounting structure shall be fixed on the reinforced cement concrete foundation, the design & drawings of which shall be submitted to Employer for review & acceptance during detailed engineering.

In case of GIS end terminations, the structure & foundations shall be suitably designed in coordination with GIS terminations during detailed engineering.

DISTRIBUTED ACOUSTIC SENSING MONITORING SYSTEM (DAS)

For the cable protection system, the bidder shall include and provide separate “Distributed Acoustic Sensing Monitoring System (DAS)” for entire route for EHV cables complete in all respects along with terminal coupling equipment, workstation and all required hardware & software for real time monitoring of acoustic fault location and detecting third party intrusion (TPI) such as digging, street breaking and anchor drag i.e. for cable protection system. The basic functional requirements of the offered system should include the following characteristics for proper monitoring.

- (i) 2P Squared DAS System
- (ii) Output Spatial Sampling Interval: 1.25m, 2.5m and 5m
- (iii) Spatial Resolution: 5m, 10m, 20m and 40m
- (iv) Laser Class: Class 1 laser product

The distributed acoustic sensing monitoring system shall be single mode optical fibre based, must be of proven technology and should be in operation for similar use along with HV cables as per latest practices. The “terminal coupling equipment” and “workstation” shall preferably be microprocessor based with HMI, for displaying acoustic event along the length of the cable system. System shall provide signaling to SAS/SCADA. The bidder shall provide brochures and catalogues for offered distributed acoustic sensing monitoring system along with the bid.

Single mode Optical fibre cables along with all jointing accessories etc. required for DAS shall also be included in the scope of bidder and shall quote accordingly under cable protection, monitoring system. Optical fibre cables associated with DAS shall be laid in the same HV cable trench. The optical fiber cable for communication purpose can be used for DAS system as per design requirement and it can be proposed accordingly.

DISTRIBUTED TEMPERATURE MONITORING SYSTEM (DTS)

The bidder shall include and provide integrated or separate “Distributed Temperature Monitoring System (DTS)” for entire route for EHV cables complete in all respects along with terminal coupling equipment, workstation and all required hardware & software for real time monitoring of conductor temperature profile and to provide load predictions. The offered system should be able to provide maximum possible transmission capacity of the cable for each circuit. The distributed temperature monitoring system shall be optical fibre based, must be of proven technology and should be in operation for similar use along with HV cables as per latest practices. The “terminal coupling equipment” and “workstation” shall preferably be microprocessor based with HMI, for displaying temperature along the length of the cable system. System shall provide potential free output contact for signaling to SAS/SCADA. The bidder shall provide brochures, methodology and catalogues for offered distributed temperature monitoring system along with the bid. Optical fibre cables along with all jointing accessories etc. required for DTS shall also be included in the scope of bidder and shall quote accordingly under cable protection, monitoring system. Optical fibre cables associated with DTS shall be laid attached to one of the HV cable per circuit.