

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATIONS FOR CROSS LINKED POLYETHYLENE INSULATED 11KV CABLES

1.00.00 **SCOPE:**

1.01.00 The scope of this package, covers the design, manufacture, stage inspection at works, inspection and testing of finished cables at manufacture's works, testing at independent test house, packing, transport and delivery to consignee's address of 6.35/11KV Three Core, 95Sq.mm, 240Sq.mm, 400Sq.mm and single core 1000Sq.mm aluminium conductor, XLPE insulated, screened, under ground Cables as per specified construction.

1.02.00 Technical Requirement: Three/single Core 6.35/11KV grade, 90°C rating heavy duty power cable with stranded compacted circular aluminium conductor shielded with extruded semi conducting compound, cross linked polyethylene insulated, shielded with extruded semi conducting compound and copper tape, shielded cores laid up with fillers, inner sheath of extruded PVC, Galvanized round steel wire Armour and PVC ST-2 overall sheath. The cables shall be FRLSH type ST2 category conforming to IS: 7098 (Part 2) and its amendments.

1.03.00 The cables should be suitable for use in solidly earthed system.

1.04.00 The Stranded Aluminium Conductor for different sizes of cable shall have the short circuit rating specified in this document, in schedule of requirement, schedule-I, Annexure TS-1.

2.00.00 **STANDARDS:**

2.01.00 The 11KV UG Cables shall, in general, meet the requirements of the latest edition of the Bureau of Indian Standards, (generally referred as IS) IS 7098 (Part-2) 2011. The cables manufactured to and meeting the testing requirements of international standards, like B.S.S. IEC or equivalent standards are also acceptable. The bidders shall enclose a copy of the equivalent international standard, in English Language, along with the Bid.

The cables and components in general shall meet the requirement Indian Standards with latest amendments or equivalent International Standards.

IS: 7098 (Part 2)	2011 with latest amendments	Specification for cross linked polyethylene insulated PVC sheathed cables
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IS: 8130	2013 :	Specification for conductors for insulated Electric Cables
IS: 3975	1999/ 2021 :	Specification for mild steel wires, strips and tapes for armouring of cables.
IS: 10810 (Part 1 to 64)	1984/ 1986/ 1987/ 1988/ 1993/ 2003:	Specification for test on cables
IS: 5831	1995 :	Specification for PVC insulation and sheath of electric cables
IS: 10418	1982 :	Specification for drums for electric cables
IS: 10462 (Part-I)	1983/ 2021 :	Fictitious calculation method for determination of dimensions of protective covering of cables: Part-I Elastomeric and thermoplastic insulated cables.

2.02.00 11KV underground cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The Bidder shall furnish the quality plan, giving in details the quality control procedures/management system.

3.00.00 **SYSTEMS DETAILS:**

General Technical Particulars:

- | | | |
|--|---|-----------------|
| 1) Nominal System Voltage (rms) (u) | - | 11 KV |
| 2) Highest System Voltage (rms) (um) | - | 12 KV |
| 3) Phase to Earth Voltage (uo) | - | 6.35 KV |
| 4) Number of Phases (for 3 core cables) | - | 3 |
| 5) Frequency | - | 50 Hz |
| 6) Variation in frequency | - | ±3% |
| 7) Type of Earthing | - | Solidly Earthed |
| 8) Basic impulse level (1.2/50 Micro Second Wave - | - | 75 KV |
| 9) Total relay & circuit break operating time | - | 15-20 Cycles |
| 10) One minute power frequency withstand voltage- | - | 28 KV |

4.00.00 **INSTALLATION CONDITIONS:**

- a) Directly buried in ground or in RCC/Hume pipes.
- b) If more than one circuit is laid in the same trench, then laid in flat formation.
- c) Metallic coverings are connected solidly to earth at both ends of the run.

- d) Normal depth of laying is 900 mm to 1000 mm (from top of round to centre of cable).
- e) Nature of soil – Heterogeneous, sandy.
- f) Soil resistivity: variable 18 to 100 Ohm – meter
- g) Soil Thermal resistivity (assumed) 120 to 150 dig. C. Cm/w.

5.00.00 **CLIMATIC CONDITIONS:**

The climatic conditions where these 11KV Cables will be installed are as under:

1	Location	Karnataka
2	Altitude	1000 M above MSL
3	Max. ambient air temperature	45 ⁰ C
4	Max. daily average air temp.	38 ⁰ C
5	Minimum ambient air temp.	10 ⁰ C
6	Ground temperature at depth of laying assumed	35 ⁰ C (Max.)
7	Isoceran level	5 ⁰ C (Min.)
8	Avg. annual rainfall	As per IS:45
9	Avg. number of rainy	1450 Sq.mm.
10	Climate	Tropical Moderately hot and humid
11	Soil	Normally dry. As per IS:1200 Part-I, 1974, likely hood of subsoil water at certain location at depth of burial of cables.

6.00.00 **DESIGN CRITERIA:**

- 6.01.00 The cables that are covered in these specifications are intended for use in the KPTCL, under the climatic conditions and installation conditions described in the technical specification.
- 6.02.00 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only in the offer made by the Bidder, giving technical reasons, and justifying the need to incorporate these features.
- 6.03.00 For continuous operation of the cables, at specified drawing, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90⁰C under normal operation and 250⁰C under short-circuit conditions.
- 6.04.00 The cables in service will be subject to daily load cycles, of two peaks during day, morning peak and evening peak with reduced loading during the nights.

6.05.00 The materials used for sheaths shall be resistant to oils, acids and alkalies.

6.06.00 The cables shall be designed to withstand the thermo mechanical forces and electrical stresses during normal operation and transient conditions.

The Cables shall be designed to have a minimum useful life span of forty years.

Core identification: The core identification for 3 core cables shall be provided, by suitable means, like, by application of coloured stripes, or by numerals or by printing on the cores as per clause 13 of IS:7093.

7.00.00 **MANUFACTURE PROCESS, CROSS LINKING OF INSULATION:**

7.01.00 Cross linking of the insulation materials (pre compounded polyethylene) shall be conforming to IS:7098 (Part-II).

7.02.00 The conductor screen shall be of extruded semi conducting compound. The insulation screen shall consist of the nonmetallic part extruded semi conducting compound with non magnetic metallic part. The XLPE insulation and the shields for conductor and insulation shall be extended in one operation.

8.00.00 **MATERIALS:**

8.01.00 CONDUCTOR: The conductor shall be of stranded construction. The material for conductor shall consist of plain aluminium of H2 or H4 grade as per clause-4 of IS:8130/2013.

The number of wires in the conductor shall be not less than the appropriate minimum number given in Table-2 of IS:8130/1984.

8.02.00 INSULATION: The insulation shall be cross linked polyethylene conforming to the requirements given in Table-1 of IS:7098 Part-II.

8.03.00 SCREENING: The screening shall consist of semi conducting compound. The metallic screen for core shall consist of copper tape. The metallic screen with Armour shall be designed to carry the minimum short circuit rating for 1 second. (The design calculations shall be furnished by the tenderer).

8.03.01 The semi-conducting compound shall withstand the operating temperature of the cable and shall be compatible with the insulting materials.

8.04.00 **Filler and inner sheath for Multi Core Cables:**

For Multi Core cables, the interstices at the centre shall be filled with a non-hygroscopic materials.

The interstices around the laid up cores shall be covered with PVC compound type S.T-2. This will form the inner sheath for Multi Cores Cables.

8.05.00 **ARMOURING:**

The armour shall be galvanized round steel wire, complying with the requirements of IS:3975. The Single Core Cables shall be armoured with hard drawn Aluminium round wire. A binder tape may be applied on the armour.

8.06.00 **OUTER SHEATH:**

The outer sheath shall consist of Poly Vinyl Chloride (PVC) compound, confirming to the requirements of Type ST-2 of IS:5831 suitable additive shall be added to give anti termite protection.

9.00.00 **CONSTRUCTION:**

The general constructional features of the cables shall be as follows:

- a) **3 Core Cables:** Stranded, Compacted, Circular, Aluminium Conductor, Conductor Screen of extruded semi conducting compound, Cross linked polyethylene insulation, shall be conforming to IS:7098 (Part-II). Insulation screen consisting of non-metallic part of extruded semi conducting compound and the metallic part of copper tape(s), Extruded PVC inner sheath, Armour (Galvanised Steel round wire), PVC ST-2 overall sheath with anti-termite treatment.
- b) **Single core Cables:** Stranded, compacted, circular Aluminium conductor, conductor screen of extruded semiconducting compound, cross linked polyethylene insulation, insulation screen consisting of Nonmetallic part of extruded semi-conducting compound & metallic part of copper type, inner sheath of extruded PVC hard drawn Aluminum round wire armour & PVC type ST2 over all sheath with anti-termite treatment.

10.00.00 **CONDUCTOR:**

10.01.01 The conductor shall be stranded, compact, circular of aluminium wires of H2 or H4 grade plain aluminium wires.

10.01.02 The conductor shall be clean, uniform in size and shape smooth and free from harmful defects.

10.01.03 Not more than two joints shall be allowed in any one of the single wire forming every complete length of conductor and no joint shall be

within 300 mm of any other joint in the same layer. The joint shall be made by brazing, silver soldering or electric or gas welding.

- 10.01.04 No joints shall be made in the conductor after it has been stranded.
- 10.02.00 **CONDUCTOR SCREEN**: The conductor screen shall be provided over the conductor consisting of extruded non metallic semi conducting compound.
- 10.03.00 **INSULATION**: The insulation shall be provided over the screened conductor with cross linked polyethylene, applied by extrusion and shall be of high quality, cross linked, shall be conforming to IS:7098 (part-2).
- 10.03.01 **THICKNESS OF INSULATION**: The average thickness of XLPE insulation shall not be less than the nominal value subject to the applicable tolerance as specified in table 4 of IS: 7098.
- 10.03.02 The insulation shall be applied to closely fit on the conductor screen, and it shall be possible to remove it without damaging the conductor.
- 10.03.03 The thickness of semi conducting screen over insulation should not be included in the thickness of Insulation.
- 10.04.00 **INSULATION SCREENING**: The Insulation screen shall be applied over the Insulations.
- 10.04.01 The Non-Metallic part of the Insulation screen shall consist of extruded Semi conducting compound.
- 10.04.02 The metallic part of the insulation screen shall consist of non-magnetic material, consisting of copper tape or tapes, and shall be applied over the non-metallic part. The metallic tape(s) shall be designed to carry the rated short circuit current.
- 10.05.00 **LAYING UP OF CORES**: For multi-core cables, the cores shall be laid together with a suitable right hand lay. The interstices at the centre shall be filled with a non-hygroscopic material.
- 10.06.00 **INNER-SHEATH FOR MULTI CORE CABLES**:
 - 10.06.01 The cores shall be laid up with a suitable right hand lay and the interstices should be filled with PVC compound type ST2 conforming to IS:5831 or equivalent standard. The filling up of interstices shall be by extrusion and this circular shape and shall bind the cores also.
 - 10.06.02 The minimum thickness of the inner sheath shall conform to Table 5 of IS: 7098 (Part-2), 2011 or equivalent standard.

10.06.03 The inner-sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation cables.

10.07.00 **ARMOURING:**

10.07.01 **Application:** The armour consisting of Galvanised steel wire for 3-core cable & Aluminium wire for 1-core cable shall be applied over the inner sheath.

10.07.02 The armour wires shall be applied as closely as possible.

10.07.03 The diameter of the galvanised round steel and hard drawn aluminium wires shall conform to IS: 7098 Part (2).

10.07.04 A binder tape may be applied on the armour.

10.07.05 The Joints in the armour wires shall be brazed/welded with joint surface and rendered smooth. The joints shall be staggered by at least 300 mm from the nearest joint in any other armour wire in the completed cable.

10.08.00 **OUTER SHEATH:**

10.08.01 The PVC outer sheath with anti termite treatment shall be extruded over the armouring.

10.08.02 The colour of the outer sheath shall be black.

10.08.03 The thickness of outer sheath shall be not less than the minimum value specified in column 6 of Table 7 of IS: 7098 (Part-2) 2011.

10.09.00 **IDENTIFICATION:** The outer-sheath shall have the following information embossed or indented on it, the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters "KPTCL". The identification shall repeat every 300/350 mm along with length of the cable.

11.00.00 **INSPECTION:**

11.01.00 **Quality Control:** The Bidder shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement.

During the manufacturing process, at all stages, inspections shall be made to check the physical and dimensional parameters, for verification to compliance to the standards.

11.02.00 The Bidder shall arrange, for inspection by the purchaser, during manufacture, if so desired by the purchaser, to verify the quality control process of the Bidder.

12.00.00 **TESTS:**

Type tested Cables shall be offered. The type tests reports shall not be older than Five (05) years as on the last date of submission of bid.

a) For cables & accessories manufactured in India:

- i. The type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by the Government or the laboratories accredited by the National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii. The type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of NABL accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

b) For cables & accessories manufactured Abroad:

- i. Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of the country where the Type test has been conducted.
- ii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.
In case of in-house type tested imported equipment of foreign OEM, the term "Purchasing Utility" covers the foreign Utility who has purchased that equipment

12.01.00 All type tests, routine, acceptance test shall be conducted in the presence of the purchaser or representative.

12.02.00 The successful Bidder shall give 15 days advance notice for inspections, and witnessing of tests by the purchaser or his representative.

12.03.01 The following type tests will be conducted on the cable.

- a) Test on conductor
- b) Test on armour wires
- c) Test for thickness of XLPE insulation (Eccentricity) & sheath
- d) Physical test on XLPE insulation
- e) Physical test for outer sheath
- f) **Partial discharge test**
- g) Bending test
- h) Di-electric power factor test
 - (i) As a function of voltage
 - (ii) As a function of temperature
- i) Insulation resistance (Volume resistivity) test
- j) Heating cycle test
- k) Impulse withstand test
- l) High voltage test
- m) Flammability test

12.03.02 The following test shall be performed successively on the same test sample of completed cable, not less than 10 M in length between the test accessories.

- a) Partial discharge test
- b) Bending test followed by partial discharge test
- c) Dielectric power factor as a function of voltage
- d) Dielectric power factor as a function of temperature
- e) Heating Cycle test, followed by dielectric power factor and function of voltage and partial discharge test.
- f) Impulse withstand test
- g) High voltage test.

12.03.03 The following additional type test shall be conducted on the cable.

- a) Oxygen Index.
- b) Flame retardant test
- c) Smoke density test
- d) Test for halogen acid gas evolution.
- e) Temperature Index.

12.04.00 **ACCEPTANCE TEST:**

12.04.01 The sampling plan for acceptance test shall be as per IS:7098 Part (2) 2011, Annexure - D.

12.04.02 (i) The following shall constitute the acceptance test.

- a) Tensile test for aluminium
- b) Wrapping test for aluminium
- c) Conductor resistance test

- d) Test for thickness of insulation (Eccentricity)
 - e) Test for thickness of inner and outer sheath
 - f) Hot-set test for insulation
 - g) Tensile strength and elongation at break test for insulation and outer sheath
 - h) Partial discharge test (on full drum length)
 - i) High voltage test
 - j) Insulation resistance (volume resistivity) test.
- (ii) The following shall constitute the additional acceptance tests for cables.
- a) Oxygen Index.
 - b) Flame retardant test
 - c) Test for halogen acid gas evolution.
 - d) Test for Smoke density.

12.05.00 **ROUTINE TEST:**

The following shall constitute routine tests:

- a) Conductor resistance test
- b) Partial discharge test on full drum length
- c) High voltage test

13.00.00 **PACKING:**

13.01.01 The cables, as per specified delivery lengths, shall be securely wound/packed in non-returnable, well seasoned sturdy wooden drums, with strong reinforcements so as to withstand rough handling during transport by Rail, Road etc., The packing should withstand storage conditions in open yards. The cable drums shall conform to IS:10418 or equivalent standard.

13.01.02 The drawing of cable drums with full detail shall be furnished, and got approved before dispatch.

13.02.00 **SEALING OF CABLE ENDS ON DRUMS:**

13.02.01 The Cable ends shall be sealed properly so that ingress of moisture is completely prevented.

13.02.02 The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a heat shrinkable cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

13.02.03 The three cores should have a over all heat shrinkable cap with adequate end clearance, and sufficient cushioning to prevent puncturing of the overall sealing cap due to stretching of the cores. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable.

13.02.04 **CABLE LENGTHS**: The cables shall be supplied in continuous lengths of 250/500 m in case of 3 core cables with a tolerance of $\pm 5\%$ of drum length.

13.02.05 **QUANTITY TOLERANCE**: $\pm 5\%$ tolerance shall be allowed on the ordered quantity.

14.00.00 **MARKING**:

The packed a cable drum shall carry the following information, clearly painted or stenciled.

- a) The letters “KPTCL”
- b) Reference to Standard and ISI Mark
- c) Manufacture’s Name or trade mark
- d) Type of Cable & Voltage grade
- e) Number of cores
- f) Nominal cores sectional area of conductor
- g) Cable code
- h) Length of cable on the drum
- i) Direction of rotation
- j) Gross weight
- k) Country of Manufacture
- l) Year of Manufacture
- m) Purchase Order No. and Date
- n) Address of consignee.

15.00.00 Cross sectional drawings of the cables giving dimensional details for each size of cable.

- a) An illustrated literature on the cable giving technical information, on current ratings, cable constants, short circuit ratings, derating factors for different types of installation packing date weights and other relevant information.

SCHEDULE-I

Annexure: TS-1

Schedule of requirement of 3 core armoured, 1 core armoured, 6.35/11KV (E) aluminium conductor, XLPE UG Cables

Sl. No.	Cross sectional area of conductor (Sq.mm.)	Minimum current rating (Amps) in ground	Minimum short circuit rating (KA/1 Sec)	Delivery length per drum (± 5%)
1	3 x 95	190	8.9	300 M
2	3 x 240	315	22.5	250 M
3	3 x 400	395	37.6	250 M
4	1 x 1000	650	94	500 M

The approximate current ratings in column 3 are for the following standard installation conditions.

i)	Maximum conductor temperature for continuous operation	90 Deg. C.
ii)	Ambient air temperature	40 Deg. C.
iii)	Ground temperature	30 Deg. C.
iv)	Thermal resistivity of soil	150 Deg. C.
v)	Depth of laying	90 cm
vi)	Maximum conductor temperature at the end of short circuit	250 Deg. C.
vii)	Method of installation	Installed single directly buried in ground/RCC duct/Pipe

GUARANTEED TECHNICAL PARTICULARS

Sl.	Particulars	unit	HT UG Cable
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No.			
1	Cables		
	a) Name of manufacturer		
	b) Place of manufacture		
2	Cable Type		A2XWY
3	Applicable specification & standards voltage Grade		IS: 7098 (Part-2) / 11kV
4	Suitable for effective Earth/Unearth system		
6	Permissible voltage & frequency variation for satisfactory operation		
7	Continuous current for standard condition as per IS:		
	a) In air (45 ⁰ C)	Amps	
	b) In Ground (30 ⁰ C)	Amps	
	c) In Duct	Amps	
8	Conductor		
	a) Material		Aluminium (H2/H4 Grade)
	b) Shape of conductor		Standard compacted circular
	c) Nominal cross sectional area	mm ²	
	d) Number of wire: (min)	No	
	e) Diameter of Wire : mm before compacting & strand Diameter	mm	
	f) Maximum DC resistance of the conductor at 20 ⁰ C	Ω/KM	As per IS
9	Conductor Screening		
	a) Material		Extruded Semiconducting compound
	b) Process		Triple Extrusion
	c) Thickness (Min)	mm	
	d) Continuous working temp	deg.C	90
	e) Max allowable temp at termination of short circuit	deg.C	250
10	Insulation:		
	a) Material		XLPE
	b) Thickness of Insulation (Nom)	mm	
	i) Between Cores	mm	
	ii) Between Cores & Inner Sheath		
	c) Minimum thickness of insulation at any one point	(mm)	
	d) Extrusion Type		Extruded
	e) Specific insulation resistance at 90 ⁰ C	Ohm-cm	
11	Insulation Screening:		

	a) Material		Extruded semi conducting compound
	b) Min. Thickness of extruded semi conducting layer	mm	
	c) Metallic Part: (Material)		Plain copper tape
	d) Size of copper Tape	mm	
	e) Whether over lapping provided		Min 5% of Overlapping
	f) Short Circuit rating in 1 sec.	KA	
12	Inner Sheath		
	a) Material		PVC -ST2
	b) Extrusion Type		Extruded
	c) Thickness (Min)	mm	
	d) Nominal Dia over Inner Sheath	mm	
13	Armouring		
	a) Material		Galvanised Steel for 3 core cable/Aluminium wire for 1 core cable.
	b) Type of armouring		Round wire
	c) Nominal Dimension of Armour wire	mm Dimension and % of Tolerance
	d) Minimum Number of Armour wire	 Numbers (Minimum)(Armouring shall be as close as practicable)
	e) Whether Galvanised		
	f) Mass of Zinc coating	gm/m ²	
	g) Nominal Dia over Armouring	mm	
	h) Short Circuit rating in 1 sec	KA	
14	Outer Sheath		
	a) Material		Extruded PVC Compound Type ST-2
	b) Extrusion type		Extruded
	c) Min. thickness of sheath	mm	
	d) Nominal Overall diameter of cable	mm	
	e) Colour	Minutes	Black
15	Short circuit withstand capacity		
	a) Short Circuit withstand capacity	KA	
	b) Duration of short circuit	sec	one
16	AC resistance per core at operating temperature	ohm/km	
17	Reactance Ohm/Km	ohm/km	
18	Capicitance per core	µF/Km	

19	Allowable maximum conductor temperature when carrying current		
20	Insulation resistance at 27 ⁰ C (Volume resistivity)	ohm-cm	
21	Loss tangent		
22	Maximum cable charging current at normal operating voltage	A/km	
23	FRLSH Properties:		
	a. Min. Oxygen Index.		
	b. Min. Temperature Index.		
	c. Max. Halogen Acid gas generation.		
	d. Max. smoke density rating.		
	e. Max. light transmittance.		
24	Recommended Minimum bending radius.	mm	
25	Safe pulling force.	Kg	
26	Cable weight	Kg/Km	
27	Length of cable per drum	Mtrs.	
	Additional data		
28	Core identification		Application of coloured stripes Red, Yellow & Blue for 3 core cable.
29	Standard Packing Length and Tolerance	Mtrs	
30	Scheme of identification of the cable		manufacturer's name or trade mark, voltage grade, year of manufacture and the letters "KPTCL". The identification shall repeat every 1000 mm along the length of the cable.