



**ODISHA POWER TRANSMISSION CORPORATION LIMITED**

# **TECHNICAL SPECIFICATION**

## **FOR 1-COAXIAL CABLES**

## **2-CONTROL & POWER CABLES**

# TECHNICAL SPECIFICATION

## ITEM- H.F. CO-AXIAL CABLE, CONTROL CABLE & TELEPHONE CABLE

### SCOPE

The specification covers the design, manufacture, testing before dispatch and setting to service of the following cables for their utility in power line carrier communication system in OPTCL.

1. H.F. Co-axial cable
2. Control cable
3. Telephone cable
4. H.F. Co-axial cable

### General:

- (a) The H.F.CO-axial cable shall be offered to connect the coupling unit (Line Matching under Symmetrical LMU) with PLC terminals. This serves maximum transfer of power between the carrier equipment to HT lines with minimum losses. The cable is also used for interconnection between two line matching units.
- (b) The high frequency cable to be offered shall be suitable for being laid in the ground or in trenches or in ducts. It shall be duly armoured and confirm IS:5802 of 1978.
- (c) The center core of the cable shall consists of tinned or enameled high purity copper conductor which has to be insulated by polythene sheath and shall be screened by tinned copper braidings. This braiding shall be sheathed by a PVC cover and GI wire enamoured and overall PVC sheathed and shall be suitable for tropical use. The six, type and quality of insulation shall be stated in the tender.
- (d) The capacitance of the co-axial cable shall be low as to minimize attenuation at the carrier frequency range.

### Tentative Particulars:

- |     |  |   |
|-----|--|---|
| 1.  | Cable impedance                            | 125 ohm or 75 ohm unbalanced. (both shall be quoted                                 |
| 2.  | Centre conductor                           | 0.8 mm dia  |
| 3.  | Dia over insulation                        | 7.6 mm  |
| 4.  | Thickness of insulation                    | 1.75 mm   |
| 5.  | Outer conductor                            | Braiding of tenced copper (Electrolytic grade) wire of 0.2 mm dia with 90% coverage |
| 6.  | Barrier                                    | Malinex tape  |
| 7.  | Inner Sheath                               | Special cable grade PVC (Black/Gray) Radial Thickness – 1.2mm.                      |
| 8.  | Braiding & Armouring                       | Single braid of 0.3mm GI wire with 79% coverage.                                    |
| 9.  | Overall sheath                             | Special cable grade PvC(Black/Gray) Radial thickness- 1.4 mm                        |
| 10. | Diameter over                              | 16.0 mm (maximum)   |
| 11. | Maximum Conductor resistance               | 35.33 ohms/Km.  |
| 12. | Dielectric strength (Core to shield)       | 5 KV rms ro 1 minute.   |
| 13. | Characteristic capacitance at 1 KHz        | 36.10 pf/meter  |
| 14. | Maximum attenuation at various frequencies |   |
|     | Frequency (KHz)                            | ds/KM   |
|     | 10   | 0.8   |
|     | 60   | 1.4   |

	300	3.30
	500	4.70
	Minimum bending	
15.	radios for installation	20 CM
16.	Insulation resistance	Meg. Ohm/Km(Min.)

2. Telephone Cable:

1) The telephone cables are of armoured or unarmoured type depending on the requirements. The telephone cable shall have 0.5 or 0.6 mm annealed tinned copper conductor, PVC insulated, cores colour coded, twisted into pairs, laid up, taped and overall PVC sheathed confirming to ITD specification. In case of armoured cable, it must be GI wiser/strip armoured with inner and outer sheathed confirming to IS: 1554 (Part-I)/1976.

2) The following cables may be quoted in the tender.

- (1) 25 pair Armoured telephone cable
- (2) 10 pair Armoured telephone cable
- (3) 10 pair unarmoured telephone cable
- (4) 5 pair unarmoured telephone cable.

3) The following cables may be quoted in the tender.

- (1) 2.5 sq.mm twin core (solid)
- (2) 10 sq.mm multistrand twin core.

4) tests – Type Test reports shall be furnished.

# TECHNICAL SPECIFICATION FOR CONTROL AND POWER CABLES

## PART 1 : SCOPE AND CONDITIONS

### 1. SCOPE

This specification covers the testing and performance requirements of power and control cables for installation on the Distribution System to be established at the location as indicated against this tender.

The equipment offered shall have been successfully type tested and the design shall have been in satisfactory operation for a period not less than two years on the date of bid opening. Compliance shall be demonstrated by submitting with the bid, (i) authenticated copies of the type test reports and (ii) performance certificates from the users..

The power and control cables shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the Project Manager shall have the power to reject any work or material, which, in his judgement, is not in full accordance therewith.

### 2. STANDARDS

Except where modified by this specification, the power and control cables shall be designed, manufactured and tested in accordance with the latest editions of the following standards.

IEC / ISO	Indian Standard	Title
IEC 811	IS-18-10810:1982	Testing cables
IEC 502	IS-7098:1985 (part 2)	LT and 3.3 - 33kVXLPE cables
IEC 502	IS - 1554:1988 (part 1)	PVC Cables .65/1.1kV
IEC 227	IS - 5819 :1970	Short circuit ratings for PVC cables
IEC 228	15-8130:1984	Conductors for insulated cables
IEC 502	IS - 6474: 1984	XLPE Cables
IEC 502		Extruded solid dielectric insulated power cables for rated voltages from 1kV to 30kV
IEC 540	IS - 5831: 1984	Test Methods for insulation and sheaths of electric cables and cords
IEC 287		Calculation of the continuous current rating of cables.
IS - 3975		Mild steel wires, strips and tapes for armouring of cables

The Bidder may propose alternative standards, provided it is demonstrated that they give a degree of quality and performance equivalent to or better than the referenced standards. Acceptability of any alternative standard is at the discretion of the Project Manager. The Bidder shall furnish a copy of the alternative standard proposed along with his bid. If the alternative standard is in a language other than English, an English translation shall be submitted with the standard. In the case of conflict the order of precedence shall be 1) IEC or ISO Standards, 2) Indian Standards, 3) other alternative standards.

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this Specification does not relieve the Contractor of the necessity of providing the goods complying with other relevant standards or recommendations.

### 3. SERVICE CONDITIONS

The service conditions shall be as follows:

- maximum altitude above sea level 11,000m
- maximum ambient air temperature 50°C
- maximum daily average ambient air temperature 35°C
- minimum ambient air temperature 0°C
- maximum temperature attainable by an object exposed to the sun 60°C
- maximum yearly weighted average ambient temperature 32°C
- maximum relative humidity 100%
- average number of thunderstorm days per annum (isokeraunic level) 70
- average number of rainy days per annum 120
- average annual rainfall 150cm
- wind pressures as per IS 802 (Part I/ Sect.I) : 1995

Wind Zones (Orissa)	2	3	5
Terrain Category 1	57.4 kg/m <sup>2</sup>	73.1 kg/m <sup>2</sup>	94.3kg/m <sup>2</sup>
Terrain Category 2	49.3	62.6	80.9
Terrain Category 3	35.6	45.3	58.4
	Light	Medium	Heavy

Environmentally, the region where the work will take place includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for outdoor insulators.

Therefore, outdoor material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive and humid coastal atmosphere.

### 4. SYSTEM CONDITIONS

The equipment shall be suitable for installation in supply systems of the following characteristics:

- Frequency 50Hz
- Nominal system voltages 33kV

		11kV
		400/230V
• Maximum system voltages:	33kV System	36.3kV
	11kV System	12.1kV
	LV System	476V
• Minimum LV voltage		340V
• Nominal short circuit levels:	33kV System	25kA
	11kV System	12.5kA
• Insulation Levels:		
1 .2/50 (j.s impulse withstand voltage		
(positive and negative polarity):	33kV System	170kV
	11kV System	75kV
• Power frequency one minute withstand		
voltage (wet and dry) rms	33kV System	70kV
	1 1kV System	28kV
	LV System	3kV
• Neutral earthing arrangements:	33kV System	solidly earthed
	11kV System	solidly earthed
	LV System	solidly earthed

## PART 2 : TECHNICAL

All power and control cables to be used in the OPTCL distribution system shall be of the cross-linked polyethelene (XLPE) or polyvinyl chloride (PVC) insulated with PVC sheathing types.

### 8. 1.1KV POLYVINYL CHLORIDE (PVC) INSULATED CABLES

#### 8.1. RATED VOLTAGE AND TEMPERATURE

The rated voltage of the cable shall be 1.1 kV and the maximum operating voltage shall not exceed 110% of the rated voltage.

These cables are suitable for use where the combination of ambient temperature and temperature rise due to load results in a conductor temperature shall not exceeding 70°C\* under normal operation and 160°C under short circuit conditions.

\*See 13.2.4 for heat resisting and general purpose applications.

#### 8.2. CABLE DESIGN

ALL LV Power cable shall be of XLPE insulation armoured type.

The cable offered shall be single-core, four core or multi-core armoured or unarmoured XLPE insulated / PVC insulated, PVC sheathed to meet the following requirements:

### 8.2.1. Conductor

- L.V System Cables (Power Cable XLPE insulated)

The conductor shall be of compacted round shape in single core cables and sector shaped in 3.5 or 4 core cables, made up from stranded aluminum wires complying with IS -8130:1984 / IEC 228. The Cable shall be of XLPE insulated with armoured.

Cables with reduced neutral conductors shall comply with the cross-sections shown in the table below.

- Control and Panel Wiring Cables (PVC insulated)

The conductor shall be of round stranded plain copper wires complying with IS - 8130:1984/IEC 228.

The conductors shall be of Flexibility Class 2 as per IS - 8130 : 1984.

### 8.2.2. Cross-Sectional area of reduced Neutral Conductors:

Nominal cross-sectional area of main conductor (mm <sup>2</sup> )	25	35	50	70	95	120	150	185	240	300	400	500	630
Cross-sectional area of reduced neutral conductor (mm <sup>2</sup> )	16	16	25	35	50	70	70	95	120	150	185	240	300

### 8.2.3. Conductor Screening Not required

### 8.2.4. Insulation

The insulation shall be of Polyvinyl Chloride (PVC) compound. The 'General Purpose' Type A shall be used for the LV cables and 'Heat Resisting' Type C for the Control and Panel Wiring cables. Both shall conform to the requirements of IS - 5831: 1984.

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
General Purpose	70°C	160°C
Heat Resisting	85°C	160°C

**The PVC insulation shall be applied by extrusion and the average thickness of insulation shall not be less than the specified nominal value and the maximum value not more than 0.1mm plus 0.1 of nominal and as specified in IS - 1554(part 1): 1988. The insulation shall be applied so that it fits closely on to the conductor and it shall be possible to remove it without damage to the conductor.**

### 8.2.5. Insulation Screening Not required

### 8.2.6. Core Identification and Laying Up of Cores 3.5 and 4 core cables shall be identified by colouring of the PVC insulation and multi core by numbers as per IS- 1 554 (part 1): 1988

Panel wiring shall have a single colour except for power supplies which shall be as per the above IS standard.

In multi-core cables, the cores shall be laid up together with a suitable lay as recommended in IS - 1554 (Part 1): 1988. The layers shall have successive right and left hand lays with the outermost layer having a right hand lay.

### 8.2.7. Inner Sheath

The laid up cores of the 3.5, 4 and multi core cables shall be covered with an inner sheath made of thermoplastic material (PVC) applied by extrusion.

The thickness of the sheath shall conform to IEC 502/IS - 1554: 1988. Single core cables shall have no inner sheath.

### 8.2.8. Armouring Only the 3.5 and 4 core LV cables will be armoured. The armour shall be applied helically in a layer of steel wires over the inner sheath of the cable. The armour shall consist of round or flat steel wires and comply with the requirements of IEC 502/IS - 1554: 1988. The steel wires shall comply with IS - 3975:

### 8.2.9. Outer Sheath

An outer sheath of polyvinyl chloride (PVC) shall be applied over the armour wires (where fitted). The sheath shall be embossed at regular intervals as per the Cable Identification clause of this

specification and the minimum thickness and properties shall comply with the requirements of IEC 502/IS - 1554: 1988. The outer sheath for cables with general purpose insulation shall be of the type ST1 PVC compound and for cables with heat resisting insulation type ST2 PVC compound conforming to the requirements of IEC 502/IS - 5831: 1984.

The outer serving shall incorporate an effective anti-termite barrier and shall be capable of withstanding a 10kV DC test voltage for five minutes after installation and annually thereafter.

Cables shall be installed as a single four core cable or three single phase cables plus neutral in a close trefoil formation.

Current ratings shall be calculated in accordance with IEC 287 "Calculation of the continuous current rating of cables with 100% load factor".

#### 8.2.10. Conductor Sizes

- The following conductor sizes will be used on the Employer's LV distribution system: 300, 120 and 50 mm<sup>2</sup> single core, 300 mm<sup>2</sup> three and a half core and 120 mm<sup>2</sup> four core.
- The following shall be used for Control and Panel Wiring:  
2.5 mm<sup>2</sup> single core, 2.5 and 4.0 mm<sup>2</sup> four core and 1.5 and 2.5 mm<sup>2</sup> multicore

#### 8.2.11. Cable Drum Length

The cable shall be supplied in 500metre lengths.

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#### **CABLE IDENTIFICATION**

The manufacturer's and Employer's name or trade mark, the voltage grade, cable designation and year of manufacture shall be indented or embossed along the whole length of the cable. The indentation or embossing shall only done on the outer sheath. The alphanumerical character size shall be not less than 20% of the circumference of the cable and be legible.

The following code shall be used to designate cables:

Constituent	Code Letter
Aluminium conductor	A
XLPE insulation	2X
PVC insulation	Y
Steel round wire armour	W
Non-magnetic round wire armour	Wa
Steel strip armour	F
Non-magnetic strip armour	Fa
Double steel round wire armour	WW
Double steel strip armour	FF
PVC outer sheath	Y

Note: No code letter is required for copper conductor

## **10. SAMPLING OF CABLES**

### **10.1. Lot**

In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

### **10.2. Scale of Sampling**

Samples shall be taken and tested from each lot to ascertain the conformity of the lot to specification.

### **10.3. Sampling Rates**

The number of samples to be selected shall be as follows:



Number of drums in the Lot	Number of Drums to be taken as samples	Permissible number of defective drums
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

#### Technical Specification for Power and Control Cables

The samples shall be taken at random. In order to achieve random selection the procedure for selection detailed in IS - 4905: 1968 shall be followed.

### 1 1 . NUMBER OF TESTS AND CRITERION FOR CONFORMITY

Suitable lengths of test samples shall be taken from each of the selected drums. These samples shall be subjected to each of the acceptance tests. A test sample shall be classed as defective if it fails any of the acceptance tests. If the number of defective samples is less than or equal to the corresponding number given in 8.3 the lot shall be declared as conforming to the requirements of acceptance test.

### 1 2. TESTS ON 1 . 1 KV PVC INSULATED CABLES

#### 12.1. Type Tests

Certification of type tests already completed by independent test laboratories shall be presented with the bid for each cable type. These tests shall be carried out in accordance with the requirements of IS -8130: 1984/IEC 502, IS - 5831:1984/IEC 540 and IEC 811 unless otherwise specified.

Type testing of 33kV, 11kV and 1.1 kV cables shall include the following:

Test	Requirement Reference	Test Method as a Part of IS-10810/IEC 811
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#### (a) Tests on conductor

Annealing test (copper)	IS-8130: 1984/IEC 502	1
Tensile test (aluminium)	IS-8130: 1984/IEC 502	2
Wrapping test (aluminium)	IS-8130: 1984/IEC 502	3
Resistance test	IS-8130: 1984/IEC 502	5

#### (b) Tests for Armour wires/strips IS - 3975: 1979/IEC 502 36 - 42

#### (c) Tests for thickness of insulation and sheath IS-5831:1984/IEC 540 6

#### (d) Physical tests for Insulation

Tensile strength and elongation at break	IS-5831:1984/IEC 540	7
Ageing in air oven	IS-5831:1984/IEC 540	11
Hot test	IS-5831:1984/IEC 540	30
Shrinkage test	IS-5831:1984/IEC 540	12
Water absorption (gravimetric)	IS-5831:1984/IEC 540	33

#### (e) Physical tests for outer sheath

Tensile strength and elongation at break	IS-5831: 1984/IEC 540	7
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Ageing in air oven	IS-5 831: 1984/IEC 540	11
Shrinkage test	IS-5831: 1984/IEC 540	12
Hot deformation	IS-5831: 1984/IEC 540	15

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Test	Requirement Reference	Test Method as a Part of IS-10810/IEC811
Loss of mass in air oven	IS-5831: 1984/IEC540	10
Heat shock	IS-5831: 1984/IEC540	14
Thermal stability	IS-5831: 1984/IEC540	IS-5831: 1984 Appendix B
(f) Partial discharge test (11 and 33kV only)	Section 13.2 of this specification	46
(g) Bending test (11 and 33kV only)	Section 13.2 of this specification	50
(h) Dielectric power factor test (11 and 33kV only)	Section 13. 4 of this specification	48
As a function of voltage		
As a function of temperature		
(j) Insulation resistance (volume resistivity) test	IS-8130: 1984/IEC502	43
(k) Heating cycle test (11 and 33kV only)	Section 13.5 of this specification	49
(l) Impulse withstand test (11 and 33kV only)	Section 13.6 of this specification	47
(m) High voltage test	Section 13.7 of this specification	45
(n) Flammability test	Section 13.8 of this specification	53

Tests (g), (h), (j), (l) and (m) are only applicable to screened cables.

Notwithstanding the conditions of the above paragraph the following tests on screened 11 and 33kV cables shall be performed successively on the same test sample of completed cable.

1. Partial discharge test
2. Bending test followed by partial discharge test
3. Dielectric power factor as a function of voltage
4. Dielectric power factor as a function of temperature
5. Heating cycle test followed by dielectric power factor as a function of voltage and partial discharge tests
6. Impulse withstand test
7. High voltage test

If a sample fails in test number 7, one more sample shall be taken for this test, preceded by tests 2 and 5.

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## **12.2. Acceptance Tests**

The following shall constitute acceptance tests:

- Tensile test (aluminium)
- Annealing test (copper)
- Wrapping test
- Conductor resistance test
- Test for thickness of insulation and sheath
- Hot set test for insulation\*
- Tensile strength and elongation at break test for insulation and outer sheath
- Partial discharge test (for screened cables only)\*\*
- High voltage test
- Insulation resistance (volume resistivity) test.
- XLPE insulation only

\*\* test to be completed on full drum of cable

## **12.3. Routine Tests**

Routine tests shall be carried out on all of the cable on a particular order. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502 and IS - 5831:1984/IEC 540 unless otherwise specified.

The following shall constitute routine tests.

- Conductor resistance test
- Partial discharge test (for 1 IkV and 33kV screened cables only)\*
- High voltage test

\* test to be completed on full drum of cable

## **12.4. Optional Test**

Cold impact test for outer sheath (IS - 5831 - 1984), which shall be completed at the discretion of the Project Manager and at the same time as test at low temperature for PVC as stipulated in the section on special tests.

## **12.5. Special tests**

Special tests shall be carried out at the Project Manager's discretion on a number of cable samples selected by the Project Manager from the contract consignment. The test shall be carried out on 10% of the production lengths of a production batch of the same cable type, but at least one production length. Special tests shall be carried out in accordance with the requirements of IEC 502 and IEC 540 unless otherwise specified.

The following special tests shall be included:

- Conductor Examination (IEC-228)
- Check of Dimensions
- 4-Hour High Voltage Test for 11 kV and 33kV Cables only
- Hot set test for XLPE Insulation

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- Test at low temperature for PVC

## **13. DETAILS OF TESTS**

### **13.1. General**

Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS -10810/IEC 502: 1994 and the additional requirements as detailed in this specification.

### **13.2. Partial Discharge Test**

Partial discharge tests shall only be made on cables insulated with XLPE of rated voltages above 1.9/3.3kV.

For multicore cables, the test shall be carried out on all insulated cores, the voltage being applied between each conductor and the metallic screen.

The magnitude of the partial discharge at a test voltage equal to  $1.5U_0$  shall not exceed 20pC for XLPE and 40pC for PVC, where  $U_0$  is the power frequency voltage between the conductor and earth or J metallic screen.

### **13.3. Bending Test**

The diameter of the test cylinder shall be  $20(d + D) \pm 5\%$  for single core cables and  $15(d + D) \pm 5\%$  for multicores, where  $D$  is the overall diameter of the completed cable in millimetres and  $d$  is the diameter of the conductor. After completing the bending operations, the test samples shall be subjected to partial discharge measurements in accordance with the requirements of this specification.

### **13.4. Dielectric Power Factor Test**

#### **13.4.1. Tan $\delta$ as a Function of Voltage**

For cables of rated voltage 1.1 kV and above

The measured value of tan  $\delta$  at  $U_0$  shall not exceed 0.004 and the increment of tan  $\delta$  between 0.5  $U_0$  and 2  $U_0$  shall not be more than 0.002.

#### **13.4.2. Tan $\delta$ as a Function of Temperature For cables of rated voltage 1.1 kV and above**

The measured value of tan  $\delta$  shall not exceed 0.004 at ambient temperature and 0.008 at 90°C for XLPE cables.

### **13.5. Heating Cycle Test**

The sample which has been subjected to previous tests shall be laid out on the floor of the test room and subjected to heating cycles by passing alternating current through the conductor until the conductor reaches a steady temperature 10°C above the maximum rated temperature of the insulation in normal operation. After the third cycle the sample shall be subjected to a dielectric power factor as a function of voltage and partial discharge test.

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### 13.7. High Voltage Test

#### 13.7.1. Type/Acceptance Test

The cable shall withstand, without breakdown, at ambient temperature, an ac voltage equal to  $3U_0$ , when applied to the sample between the conductor and screen/armour (and between conductors in the case of unscreened cable). The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

If while testing, interruption occurs during the 4 hour period the test shall be prolonged by the same extent. If the interruption period exceeds 30 minutes the test shall be repeated.

#### 13.7.2. Routine Test

Single core screened cables, shall withstand, without any failure, the test voltages given in this specification for a period of five minutes between the conductor and metallic screen.

Single core unscreened cables shall be immersed in water at room temperature for one hour and the test voltage then applied for 5 minutes between the conductor and water.

Multicore cables with individually screened cores, the test voltage shall be applied for 5 minutes between each conductor and the metallic screen or covering.

Multicore cables without individually screened cores, the test voltage shall be applied for 5 minutes in succession between each insulated conductor and all the other conductors and metallic coverings, if any.

#### 13.7.3. Test Voltages

The power frequency test voltage shall be  $2.5 U_0 + 2\text{kV}$  for cables at rated voltages, up to and including 3.8/6.6kV, and  $2.5 U_0$  for cables at higher rated voltages.

Values of single phase test voltage for the standard rated voltages are as given in the following table:

Voltage Grade kV	Test Voltage	
	Between conductors and screen/armour kV(rms)	Between conductors kV(rms)
0.65/1.1	3	3

If, for three core cables, the voltage test is carried out with a three phase transformer, the test voltage between the phases shall be 1.732 times the values given in the above table.

When a DC voltage is used, the applied voltage shall be 2.4 times the power frequency test voltage. In all instances no breakdown of the insulation shall occur.

### 13.8. Flammability Test

The period for which the cable shall burn after the removal of the flame shall not exceed 60 seconds and the unaffected portion (uncharred) from the lower edge of the top clamp shall be at least 50mm.

## 14. CABLE ACCESSORIES

The accessories are for the following types of cable:

33kV XLPE, single core round stranded plain aluminium conductor to IEC 228/IS - 8130: 1984, semi-conducting conductor screen, XLPE insulation, non - metallic semi-conducting insulation screen with non - magnetic tape or metallic cover, inner PVC sheath, non-magnetic wire or strip armour and PVC outer sheath.

11kV XLPE, single or three core round stranded plain aluminium conductor to IEC 228/IS - 8130: 1984, semiconducting conductor screen, XLPE insulation, non - metallic semiconducting insulation screen with non - magnetic tape or metallic cover, inner PVC sheath, non-magnetic wire or strip armour for single core cables, and steel wire armour on three core cables and PVC outer sheath.

LV (1100V) PVC, single, three and a half and four core round or sector shaped stranded plain aluminium grade H4 conductor, PVC insulation, inner PVC sheath, steel wire armour for three phase cables and P.V.C. outer sheath.

#### **14.1. JOINTS AND TERMINATIONS**

Joints and terminations shall be supplied in complete kit form with all materials and components required to complete the installation. A complete set of instructions for the joint or termination shall also be included in each kit.

Heat shrink pre-moulded joints and terminations shall be required for all XLPE and PVC cables and for transition joints.

All components shall be capable of being stored without damage or deterioration at temperatures up to 50°C. The material expiry date shall be marked on all packages, where appropriate.

Details of all equipment, tools and protective clothing required to complete the joint or termination shall be included with each joint or termination kit.

Components shall not be adversely affected in any manner by contact with other materials normally used in the construction of cable joints or terminations and shall not increase the rate of corrosion of any metals with which they may come into contact.

Components supplied with adhesive coatings shall have means to prevent the coated surfaces from adhering to each other.

Joints and terminations for armoured or screened cables shall include all items needed for wire or tape clamping. Rings shall be provided for such application.

The recovered thickness of insulation over the connector shall be uniform and equal to or greater than the cable insulation thickness as given in IEC 502/IS - 1554/IS - 7098.

The protection provided by the galvanised steel wire armouring shall be reinstated over the joint (s). Electric field stress control shall be provided on all of the High Voltage joints and terminations.

Joints shall provide waterproofing, mechanical and electrical protection, and be completely sealed from cable jacket to cable jacket. Joints shall accommodate crossing of the cores.

Where required 33kV, 1 IkV and 1.1 kV cable joints shall be straight through joints only.

Terminations shall be designed to provide a complete moisture seal, including the crotch area of multi-core cables and complete re-jacketing of the individual cores, conforming to Class 1 terminations as per IEEE 48. They shall be generally suitable for indoor and outdoor installation, be resistant to ultra violet radiation and chemical attack.

**Minimum creepage distance for outdoor terminations shall not be less than:**

Adhesives used shall have a softening temperature of not less than 90° C, be compatible with other components and after curing shall not flow at temperatures of normal service.

1.1 kV, 1 IkV and 33kV joints and terminations shall be designed so that no insulating or semi-conducting tapes shall be required. Reinstallation of the insulation and semi - conducting cover shall be achieved with the use of multiple layers of heat shrinkable tubes possessing high dielectric strength and thermal stability.

Phase identification colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Project Manager may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Project Manager may determine.

All cables shall be identified and shall have phase colours marked at their termination.

#### **14.2. CONNECTORS/TERMINALS**

Connectors and terminals shall perform without distress under normal loading, cyclic loading and fault conditions, and shall not limit the rating of the cables which they joint.

33kV connections shall be compressed by hydraulically operated tools and 1 IkV/LV connectors by hand operated tools. The range of connectors/terminals should be kept to a minimum so as to limit the range of dies which may be required and the use of die-less compression tools of the tension or non-tension type shall be permitted. Only approved and proven compression tools supplied by a reputable manufacturer shall be used.

The ends of connectors/terminals shall be suitably chamfered or coned to facilitate insertion of the conductors. Connectors shall have a solid central barrier to facilitate the insertion of the conductor to the correct depth.

The following items of information shall be clearly stamped on each connector/terminal:

- Manufacturer's name or trade mark.
- The conductor size (metric) for which the connector/terminal is suitable.
- The die number or size suitable for compressing the connector/terminal.

- The part of the connector/terminal surface to be compressed.
- The sequence of die action from the starting point and finishing point.

Compounds or greases for improving contact between the connector/terminal and the conductor are permitted. They must, however, be chemically neutral to the connector/terminal and conductor materials and must be present in position in the delivered connectors/terminals.

Cable connectors/terminals shall be able to accommodate typical variations in dimensions of cables supplied by different manufacturers.

Connector/terminal material shall not react chemically with the cable conductors to which they are connected.

#### Size and type of connectors required:

Straight through connectors for the following conductors:

- 300 - 300 mm<sup>2</sup> stranded round plain aluminium
- 185-185 mm<sup>2</sup> stranded round plain aluminium

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120-120 stranded sector shaped plain aluminium Termination lugs for the following conductors:

- 300 mm<sup>2</sup> stranded round and sector shaped plain aluminium
- 185 mm<sup>2</sup> stranded round plain aluminium
- 150 mm<sup>2</sup> stranded sector shaped plain aluminium for the neutral of the 3.5 core 300 mm<sup>2</sup> cable.
- 120 mm<sup>2</sup> stranded round and sector shaped plain aluminium
- 70 mm<sup>2</sup> stranded round plain aluminium
- 50 mm<sup>2</sup> stranded round plain aluminium

Termination lugs shall be suitable for bi-metallic connections.

Terminals for pole top terminations of 33kV and 1 IkV cables shall be of the post type capable of accepting a tap off connector. Appropriate tap off connectors shall be provided for making connections from the cable to the line conductors.

### 14.3. CONTROL/LV WIRING ACCESSORIES 14.3.1. Terminations

Control wire terminations shall be made with solderless crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire termination. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule. Numbers 6 and 9 shall not be included for ferrules purposes except where underlined and identified as 6 and 9.

LVAC cable terminals shall be provided with adequate size crimp type lugs. The lugs shall be applied with the correct tool, which shall be regularly checked for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the contractor at every cable entry to mechanism boxes, cabinets and kiosks. The Contractor shall be responsible for drilling the cable gland plate to the required size.

Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug in order to connect the gland to the earth bar.

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## PART 3 : GENERAL PARTICULARS AND GUARANTEES

### 15. COMPLIANCE WITH SPECIFICATION

The power and control cables shall comply in all respects with the requirements of this specification. However, any minor departure from the provisions of the specification shall be disclosed at the time of bidding in the Non Compliance Schedule in this document.

The mass and dimensions of any item of equipment shall not exceed the figures stated in the schedules.

### 16. COMPLIANCE WITH REGULATIONS

All the equipment shall comply in all respects with the Indian Regulations and Acts in force.

The equipment and connections shall be designed and arranged to minimise the risk of fire and any damage which might be caused in the event of fire.

### 17. QUALITY ASSURANCE, INSPECTION AND TESTING

#### 17.1. General

To ensure that the supply and services under the scope of this Contract, whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at any other place of work are in accordance with the Specification, with the regulations and with relevant authorised international or Indian Standards, the Contractor shall adopt suitable Quality Assurance Programmes and Procedures to ensure that all activities are being controlled as necessary.

The quality assurance arrangements shall conform to the relevant requirements of ISO 9001 or ISO 9002 as appropriate.

The systems and procedures which the Contractor will use to ensure that the Plant complies with the Contract requirements shall be defined in the Contractor's Quality Plan for the Works. The Contractor shall operate systems which implement the following:

**Hold Point** "A stage in the material procurement or workmanship process beyond which work shall not proceed without the documented approval of designated individuals or organisations."

The Project Manager's written approval is required to authorise work to progress beyond the Hold Points indicated in approved Quality Plans.

**Notification Point** "A stage in material procurement or workmanship process for which advance notice of the activity is required to facilitate witness."

If the Project Manager does not attend after receiving documented notification in accordance with the agreed procedures and with the correct period of notice then work may proceed.

#### 17.2. Quality Assurance Programme

Unless the Contractor's Quality Assurance System has been audited and approved by the Project Manager, a Quality Assurance Programme for the Works shall be submitted to the Project Manager for approval a minimum of one month from contract award, or such other period as shall be agreed with the Project Manager. The Quality Assurance Programme shall give a description of the Quality System for the Works and shall, unless advised otherwise, include details of the following:

- The structure of the organisation;
- The duties and responsibilities assigned to staff ensuring quality of work;
- The system for purchasing, taking delivery and verification of materials;

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- The system for ensuring quality of workmanship;
  - The system for control of documentation;
  - The system for the retention of records;
  - The arrangements for the Contractor's internal auditing;
  - A list of the administration and work procedures required to achieve and verify Contract's quality requirements. These procedures shall be made readily available to the Project Manager for inspection on request.

#### 17.3. Quality Plans

The Contractor shall draw up for each section of the work Quality Plans which shall be submitted to the Project Manager for approval at least two weeks prior to the commencement of work on the



particular section. Each Quality Plan shall set out the activities in a logical sequence and, unless advised otherwise, shall include the following:

- An outline of the proposed work and programme sequence;
- The structure of the Contractor's organisation for the Contract;
- The duties and responsibilities assigned to staff ensuring quality of work for the Contract;
- Hold and Notification Points;
- Submission of engineering documents required by the specification;
- The inspection of materials and components on receipt;
- Reference to the Contractor's Work Procedures appropriate to each activity;
- Inspection during fabrication/construction;
- Final inspection and test.

**17.4. Non-conforming product**

The Project Manager shall retain responsibility for decisions regarding acceptance, modification or rejection of non-conforming items.

**17.5. Sub-contractors**

The Contractor shall ensure that the Quality Assurance requirements of this specification are followed by any sub-contractors appointed by him under the Contract.

The Contractor shall assess the sub-contractor's Quality Assurance arrangements prior to his appointment to ensure compliance with the appropriate ISO 9000 standard and the specification. Auditing of the sub-contractor's Quality Assurance arrangements shall be carried out by the Contractor and recorded in such a manner that demonstrates to the Project Manager the extent of the audits and their effectiveness.

**17.6. Inspection and testing**

The Project Manager shall have free entry at all times, while work on the contract is being performed, to all parts of the manufacturer's works which concern the processing of the equipment ordered. The manufacturer shall afford the Project Manager without charge, all reasonable facilities to assure that the equipment being furnished is in accordance with this specification.

The equipment shall successfully pass all the type tests, acceptance tests and routine tests referred to in the section on Tests and those listed in the most recent edition of the standards given in this specification.

The Project Manager reserves the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.

Type tests shall be carried out at an independent testing laboratory or be witnessed by a representative of such laboratory or some other representative acceptable to the Project Manager. Routine and acceptance tests shall be carried out by the Contractor at no extra charge at the manufacturer's works.

Type Test certificates shall be submitted with the bid for evaluation. The requirement for additional type tests will be at the discretion of the Project Manager.

The Project Manager may witness routine, acceptance and type tests. In order to facilitate this, the Contractor shall give the Project Manager a minimum of four weeks notice that the material is ready for testing. If the Project Manager does not indicate his intention to participate in the testing, the manufacturer may proceed with the tests and shall furnish the results thereof to the Project Manager.

Full details of the proposed methods of testing, including connection diagrams, shall be submitted to the Project Manager by the Contractor for approval, at least one month before testing.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Contractor, who shall provide the Project Manager with all the test facilities which the latter may require, free of charge. The Project Manager shall have the right to select the samples for test and shall also have the right to assure that the testing apparatus is correct. Measuring apparatus for routine tests shall be calibrated at the expense of the Contractor at an approved laboratory and shall be approved by the Project Manager.

The Contractor shall be responsible for the proper testing of the materials supplied by sub-contractors to the same extent as if the materials were completed or supplied by the Contractor.

Any cost incurred by the Project Manager in connection with inspection and re-testing as a result of failure of the equipment under test or damage during transport or off-loading shall be to the account of the Contractor.

The Contractor shall submit to the Project Manager five signed copies of the test certificates, giving the results of the tests as required. No materials shall be dispatched until the test certificates have been received by the Project Manager and the Contractor has been informed that they are acceptable.

The test certificates must show the actual values obtained from the tests, in the units used in this specification, and not merely confirm that the requirements have been met.

In the case of components for which specific type tests or routine tests are not given in this specification, the Contractor shall include a list of the tests normally required for these components. All materials used in the Contract shall withstand and shall be certified to have satisfactorily passed such tests.

No inspection or lack of inspection or passing by the Project Manager's Representative of equipment or materials whether supplied by the Contractor or sub-contractor, shall relieve the Contractor from his liability to complete the contract works in accordance with the contract or exonerate him from any of his guarantees.

#### **17.7. Guarantee**

The Contractor shall guarantee the following :

- Quality and strength of materials used;
- Satisfactory operation during the guarantee period of one year from the date of commissioning, or 18 months from the date of acceptance of the equipment by the Project Manager following delivery, whichever is the earlier;
- Performance figures as supplied by the Bidder in the schedule of guaranteed particulars.

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#### **18. PROGRESS REPORTING**

The Contractor shall submit for approval within four weeks of the starting date of the contract, an outline of production, inspection, delivery (and installation) in a chart form. Within a further period of four weeks, the Contractor shall provide a detailed programme of the same information in a form to be agreed by the Project Manager. The Contractor shall submit two copies of monthly progress reports not later than the 7th day of the following month. The reports shall show clearly and accurately the position of all activities associated with the material procurement, manufacture, works tests and transport, with regard to the agreed contract programme.

(The preferred format for presentation of programmes is MS Project Version 4.0. Programmes and monthly updates should be submitted on 3.5" diskettes.)

The design aspect of the progress report shall include a comprehensive statement on drawings, calculations and type test reports submitted for approval.

The position on material procurement shall give the dates and details of orders placed and indicate the delivery dates quoted by the manufacturer. If any delivery date has an adverse effect on the contract programme, the Contractor shall state the remedial action taken to ensure that delays do not occur.

The position on manufacture shall indicate the arrival of raw material and the progress of manufacture. Any events that may adversely affect completion in the manufacturer's works shall also be reported.

All works tests done shall be listed and test results shall be remarked upon. Any test failure shall be highlighted.

The dispatch of each order shall be monitored on the progress report giving the date by which the equipment will be available for transport, the estimated time of arrival on site and the dates actually achieved.

Delays or test failures in any part of the programme which may affect any milestone or final completion dates shall be detailed by the Contractor who shall state the action taken to effect contract completion in accordance with the contract programme.

#### **19. SPARE PARTS AND SPECIAL TOOLS**

The Contractor shall provide prices for spare conductor, joints and termination equipment.

The Project Manager may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works. The Project Manager may order additional spares at any time during the contract period at the rates stated in the Contract Document.

A spare parts catalogue with price list shall be provided for the various cables, joints and termination equipment and this shall form part of the drawings and literature to be supplied.

Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the equipment and must be suitably marked and numbered for identification.

Spare parts shall be delivered suitably packed and treated for long periods in storage. Each pack shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts list in the installation and maintenance instructions.

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## **20. PACKING AND SHIPPING**

### **20.1. Packing**

The cable shall be wound on strong drums or reels capable of withstanding all normal transportation and handling.

Each length of cable shall be durably sealed before shipment to prevent ingress of moisture. The drums, reels or coils shall be lagged or covered with suitable material to provide physical protection for the cable during transit and during storage and handling operations.

In the case of steel drums adequate precautions shall be taken to prevent damage being caused by direct contact between the cable sheath and the steel. These precautions shall be subject to the approval of the Project Manager.

If wooden drums are used then the wood shall be treated to prevent deterioration from attack by termites and fungi.

Each drum or reel shall carry or be marked with the following information:

- Individual serial number
- Employer's name
- Destination
- Contract Number
- Manufacturer's Name
- Year of Manufacture
- Cable Size and Type
- Length of Conductor (metres)
- Net and Gross Mass of Conductor (kg)
- All necessary slinging and stacking instructions.
- Destination;
- Contractor's name;
- Name and address of Contractor's agent in Orissa;
- Country of origin;

The direction of rolling as indicated by an arrow shall be marked on a flange.

### **20.2. Storage**

The site selected for the storage of cable drums shall be well drained and preferably have a concrete/firm surface which will prevent the drums sinking into the ground or being subjected to excess water thus causing flange rot.

All drums shall be stood on battens, in the upright position, and in such a manner to allow sufficient space between them for adequate air circulation. During storage the drums shall be rotated 90° every three months. In no instances shall the drums be stored "flat" on their flanges or one on top of each other.

### **20.3. Shipping**

The Contractor shall be responsible for the shipping of all cables, drums and reels supplied from abroad to the ports of entry and for the transport of all goods to the various specified destinations including customs clearance, offloading, warehousing and insurance.

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The Contractor shall inform himself fully as to all relevant transport facilities and requirements and loading gauges and ensure that the equipment as packed for transport shall conform to these limitations. The Contractor shall also be responsible for verifying the access facilities specified.

The Contractor shall be responsible for the transportation of all loads associated with the contract works and shall take all reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute loads so that the risk of damage shall be avoided. The Contractor shall immediately report to the Project Manager any claims made against the Contractor arising out of alleged damage to a highway or bridge.

All items of equipment shall be securely clamped against movement to ensure safe transit from the manufacturer's facilities to the specified destinations (work sites.)

The Contractor shall advise the storage requirements for any plant and equipment that may be delivered to the Project Manager's stores. The Contractor shall be required to accept responsibility for the advice given in so far as these arrangements may have a bearing on the behaviour of the equipment in subsequent service.

### **20.4. Hazardous substances**

The Contractor shall submit safety data sheets in a form to be agreed for all hazardous substances used with the equipment. The Contractor shall give an assurance that there are no other substances classified as hazardous in the equipment supplied. The Contractor shall accept responsibility for the disposal of such hazardous substances, should any be found.

The Contractor shall be responsible for any injuries resulting from hazardous substances due to non compliance with these requirements.

## **21. SUBMITTALS**

### **21.1. Submittals required with the bid**

The following shall be required in duplicate :

- completed technical data schedule;
- descriptive literature giving full technical details of equipment offered;
- type test certificates, where available, and sample routine test reports;
- detailed reference list of customers already using equipment offered during the last 5 years with particular emphasis on units of similar design and rating;
- details of manufacturer's quality assurance standards and programme and ISO 9000 series or equivalent national certification;
- deviations from this specification. Only deviations approved in writing before award of contract shall be accepted;

### **21.2. Submittals required after contract award**

21.2.1. Programme Five copies of the programme for production and testing.

21.2.2. Technical particulars

Within 30 days of contract award five bound folders with records of the technical particulars relating to the equipment. Each folder shall contain the following informatio

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- general description of the equipment and all components, including brochures;
- technical data schedule, with approved revisions;
- calculations to substantiate choice of electrical and mechanical component size/ratings;
- statement drawing attention to all exposed points in the equipment at which copper, aluminium or aluminium alloy parts are in contact with or in close proximity to other metals and stating clearly what protection is employed to prevent corrosion at each point;
- detailed installation and commissioning instructions;

At the final hold point for Project Manager approval prior to delivery of the equipment the following shall be submitted:

- inspection and test reports carried out in the manufacturer's works;

- Installation and maintenance instructions. 21.2.3. Operation and maintenance instructions  
A copy of the detailed installation and commissioning instructions shall be supplied with each type cable joint and termination equipment.

### **21.3. Drawings**

Within 30 days of contract commencement the Contractor shall submit, for approval by the Project Manager, a schedule of the drawings to be produced detailing which are to be submitted for "Approval" and which are to be submitted "For Information Only". The schedule shall also provide a programme of drawing submission, for approval by the Project Manager, that ensures that all drawings and calculations are submitted within the period specified above.

All detail drawings submitted for approval shall be to scale not less than 1:20. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated on the drawings. All documents and drawings shall be submitted in accordance with the provisions of this specification and shall become the property of the Employer.

All drawings and calculations submitted to the Project Manager shall be on international standard size paper, AO, A1, A2, A3, or A4. All such drawings and calculations shall be provided with a contract title block, which shall include the name of the Employer and Consultants and shall be assigned a unique project drawing number. The contract title block and project numbering system shall be agreed with the Project Manager.

Lettering sizes and thickness of lettering and lines shall be selected so that if reduced by two stages to one quarter of their size, the alphanumeric characters and lines are still perfectly legible so as to enable them to be microfilmed.

For presentation of design drawings and circuit documents IEC Publication 617 or equivalent standards for graphical symbols are to be followed.

### **22. APPROVAL PROCEDURE**

The Contractor shall submit all drawings, documents and type test reports for approval in sufficient time to permit modifications to be made if such are deemed necessary and re-submit them for approval without delaying the initial deliveries or completion of the contract work. The Project Manager's representative shall endeavour to return them within a period of four weeks from the date of receipt.

Three copies of all drawings shall be submitted for approval and three copies for any subsequent revision. The Project Manager reserves the right to request any further additional information that may be considered necessary in order to fully review the drawings. If the Project Manager is satisfied with

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the drawing, one copy will be returned to the Contractor marked with "Approved" stamp. If the Project Manager is not totally satisfied with the drawing, then "Approved Subject to Comment" status will be given to it and a comment sheet will be sent to the Contractor. If the drawing submitted does not comply with the requirements of the specification then it will be given "Not Approved" status and a comment sheet will be sent to the Contractor. In both these cases the Contractor will have to modify the drawing, update the revision column and resubmit for final Approval. Following approval, twenty copies of the final drawings will be required by the Project Manager.

Any drawing or document submitted for information only should be indicated as such by the Contractor. Drawings and documents submitted for information only will not be returned to the Contractor unless the Project Manager considers that such drawing needs to be approved, in which case they will be returned suitably stamped with comments.

The Contractor shall be responsible for any discrepancies or errors in or omissions from the drawings, whether such drawings have been approved or not by the Project Manager. Approval given by the Project Manager to any drawing shall not relieve the Contractor from his liability to complete contract works in accordance with this specification and the condition of contract nor exonerate him from any of his guarantees.

If the Contractor needs approval of any drawing within a period of less than four weeks in order to avoid delay in the completion of supply, he shall advise the Project Manager when submitting the drawings and provide an explanation of the document's late submission. The Project Manager will endeavour to comply with the Contractor's timescale, but this cannot be guaranteed.

## **23. SURFACE TREATMENT**

Where galvanised steel armour wire is used then the Contractor shall indicate his galvanising process utilised and its conformance with this specification

### **23.1. Galvanising**

All galvanising shall be carried out by the hot dip process, in accordance with Specification ISO 1460 or IS 2629. However, high tensile steel nuts, bolts and spring washers shall be electro galvanised to Service Condition 4. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paint, varnish, oil, welding slag and other foreign matter completely removed. All protuberances which would affect the life of galvanising shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard BS 729, ISO 1460 or IS 2629 and shall be not less than 0.61kg/m<sup>2</sup> with a minimum thickness of 86 microns for items of thickness more than 5mm, 0.46 kg/m<sup>2</sup> (64 microns) for items of thickness between 2mm and 5mm and 0.33 kg/m<sup>2</sup> ( 47 microns ) for items less than 2mm thick.

Parts shall not be galvanised if their shapes are such that the pickling solution cannot be removed with certainty or if galvanising would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanised unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanising the method used for repair shall be subject to the approval of the Project Manager or that of his representative.

Repair of galvanising on site will generally not be permitted.

The threads of all galvanised bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Project Manager. All nuts shall be galvanised. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanising tank must therefore be sufficiently large to permit galvanising to be carried out by one immersion.

After galvanising no drilling or welding shall be performed on the galvanised parts of the equipment excepting that nuts may be threaded after galvanising. To avoid the formation of white rust, galvanised material shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation.

The galvanised steel shall be subjected to test as per IS-2633.

## **24. COMPLETENESS OF CONTRACT**

All fittings or accessories, although not specifically mentioned herein, but necessary or usual for similar equipment and their efficient performance shall be provided by the Contractor without extra charges. The bid shall clearly indicate if any additional equipment or parts would be necessary to give a complete offer and if so, the details and the prices shall be included in the bid.

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# **MORE INFORMATION ON POWER & CONTROL CABLES [FOR WORKING VOLTAGES UP TO AND INCLUDING 1100 V]**

## **CRITERIA FOR SELECTION OF POWER & CONTROL CABLES**

- 1.1 Aluminium conductor XLPE insulated armoured cables shall be used for main power supply purpose from LT Aux. Transformers to control room, between distribution boards and for supply for colony lighting from control room.
- 1.2 Aluminium conductor PVC insulated armoured power cables shall be used for various other applications in switch yard area/control room except for control/protection purposes.
- 1.3 For all control/protection/instrumentation purposes PVC insulated control cables of minimum 2.5 sq. mm. size with stranded Copper conductors shall be used.  
The sizes of power cables to be used per feeder in different application shall be as applicable, described here under.
- 1.5 Bidder may offer sizes other than the sizes specified in clause 1.4. In such case and for other application where sizes of cables have not been indicated in the specification, sizing of power cables shall be done keeping in view continuous current, voltage drop & short-circuit consideration of the system. Relevant calculations shall be submitted by bidder during detailed engineering for purchaser's approval.
- 1.6. Cables shall be laid conforming to IS : 1255.
- 1.7 While preparing cable schedules for control/protection purpose following shall be ensured:
  - 1.7.1 Separate cables shall be used for AC & DC.
  - 1.7.2 Separate cables shall be used for DC1 & DC2.
- 1.8 For different cores of CT & CVT separate cable, core wise shall be used .The minimum sizes of the conductor for each terminal shall be 2X2.5 sqmm.
- 1.9 For control cabling, including protection circuits, minimum 2.5 sq.mm. size copper cables shall be used per connection.

## **TECHNICAL REQUIREMENTS**

### **2. General**

- 2.1 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 2.2 They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions.
- 2.3 The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.
- 2.4 The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects. All Aluminium used in the cables for conductors shall be of H2 grade. In case of single core cables armours shall be of H4 grade Aluminium.
- 2.5 The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

- 2.6 Progressive sequential marking of the length of cable in metres at every one meter shall be provided on the outer sheath of all cables.
- 2.7 Strip wire armouring method (a) mentioned in Table 5, Page-6 of IS : 1554 (Part 1 ) – 1988 shall not be accepted for any of the cables. For control cables only round wire armouring shall be used.
- 2.8 The cables shall have outer sheath of a material with an oxygen index of not less than 29 and a temperature index of not less than 250°C.
- 2.9 All the cables shall pass fire resistance test as per IS:1554 (Part-I)
- 2.10 The normal current rating of all PVC insulated cables shall be as per IS:3961.
- 2.11 Repaired cables shall not be accepted.

### **3. XLPE Power Cables**

- 3.1 The XLPE (90°C) insulated cables shall be of FR type, C1 category conforming to IS:7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables.

### **4. PVC Power Cables**

- 4.1. The PVC (70°C) insulated power cables shall be of FR type, C1 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS: 5831 for all cables.

### **5. PVC Control Cables**

- 5.1 The PVC (70°C) insulated control cables shall be of FR type C1 category conforming to IS: 1554 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour .

## **6. HV POWER CABLES [ FOR WORKING VOLTAGES FROM 3.3 kV AND INCLUDING 33 kV]**

### **6.1. HV POWER CABLE FOR AUXILIARY POWER SUPPLY**

The HV cable of voltage class as specified for LT transformer shall be, XLPE insulated, armoured cable conforming to IS 7098 (Part-II) or IEC 60502-2 1998. Terminating accessories shall conform to IS 17573-1992 or IEC 61442/IEC60502-4 1998.



## 6.2. Constructional Requirements

*Cable shall have compacted circular Aluminium conductor, Conductor screened with extruded semi conducting compound , XLPE insulated, insulation screened with extruded semi conducting compound, armoured with non-magnetic material, followed by extruded PVC outer sheath(Type ST-2), with FR properties .*

- 6.3 Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of the cable.
- 6.4 The cables shall have outer sheath of a material with an Oxygen Index of not less than 29 and a Temperature index of not less than 250°C.

## 7. TYPE TESTS

7.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS.

**THE SIZES OF POWER CABLES TO BE USED PER FEEDER IN DIFFERENT APPLICATION SHALL BE AS APPLICABLE, DESCRIBED HERE UNDER.**

S.No.	From	To	Cable size	Cable type
1.	Main Board Switch	LT Transformer	2-1C X 630 mm <sup>2</sup> per phase 1-1C X 630 mm <sup>2</sup> for neutral	XLPE
2.	Main Board Switch	AC Distribution Board	2-3½C X 300 mm <sup>2</sup>	XLPE
3.	Main Board Switch	Oil Filtration Unit	1-3½C X 300 mm <sup>2</sup>	XLPE
4.	Main Board Switch	Colony Lighting	1-3½C X 300 mm <sup>2</sup>	XLPE
5.	Main Board Switch	HVW pump LCP	1-3½C X 300 mm <sup>2</sup>	XLPE
6.	Main Board Switch	Main Lighting distribution board	1-3½C X 300 mm <sup>2</sup>	XLPE
7.	AC Distribution Board	D.G. Set AMF Panel	2-3½C X 300 mm <sup>2</sup>	PVC
8	AC Distribution Board	Emergency Lighting distribution board	1-3½C X 70 mm <sup>2</sup>	PVC
9	AC Distribution Board	ICT MB	1-3½C X 70 mm <sup>2</sup>	PVC
10	AC Distribution Board	Bay MB	1-3½C X 70 mm <sup>2</sup>	PVC
11	Bay MB	AC Kiosk	1- 3 ½ x 35 mm <sup>2</sup>	PVC
12	AC Distribution Board	Battery Charger	1-3½C X 70 mm <sup>2</sup>	PVC
13	DCDB	Battery	2-1C X 150 mm <sup>2</sup>	PVC
14	DCDB	Battery Charger	2-1C X 150 mm <sup>2</sup>	PVC
15	DCDB	Protection/PLCC panel	1-4C X 16 mm <sup>2</sup>	PVC
16	Main Lighting DB	Lighting	1-3½C X 35 mm <sup>2</sup>	PVC

		panels(Indoor)		
<b>17</b>	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm <sup>2</sup>	PVC
<b>18</b>	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm <sup>2</sup>	PVC
<b>19</b>	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm <sup>2</sup>	PVC
<b>20</b>	Lighting Panel	Sub lighting panels	1-4C X 16 mm <sup>2</sup>	PVC
<b>21</b>	Lighting Panel	Street Lighting Poles	1-4C X 16 mm <sup>2</sup>	PVC
<b>22</b>	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	1-2C X 6 mm <sup>2</sup>	PVC

#### **PART 4: SCHEDULES**

##### **25. TECHNICAL DATA SCHEDULES**

##### **3. 1100V Cable Schedule**

**Remarks:- a) All the LV Power Cable shall be XLPE with insulated armoured Aluminum Cable.  
b) All the Control Cable shall be PVC insulated Cables.**

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