Date:19.09.2013/08.01.2014

TECHNICAL SPECIFICATION

FOR

10C x 2.5 Sq.mm, 4C x 2.5 Sq.mm and 2C x 2.5 Sq.mm COPPER CONTROL CABLE

1.0 SCOPE:

1.1 This specification provides for the design, manufacture, testing, inspection and testing before despatch, supply and delivery, Free at Destination Stores of ISI marked un armoured, multi core, PVC insulated and sheathed copper control cables for use on AC single phase or three phase (earthed or unearthed) systems of rated voltages up to and including 1100V or DC systems of rated voltages up to and including 1500V to earth specified herein conforming to IS:1554 (Part I/1988) with latest amendments and as per specification detailed for their satisfactory operation in different substations in AP-PDCL. Sizes of the LT control cable are:

i. 2C x 2.5 sq. mm
ii. 4C x 2.5 sq. mm
iii. 10C x 2.5 sq. mm

1.2 The Control Cable shall conform in all respects to high standard of Engineering design workmanship and latest revision of relevant standards at the time of offer and the purchaser shall have the power to reject any work or material, which in his Judgment is not in full accordance there with.

2.0 STANDARDS:

The control cable shall conform to the latest revisions with amendments with available of relevant standards, rules and codes some of which are listed hereunder for ready reference, unless otherwise specified else where in this specification.

IS:1554 (Part-1)	:	Specification for PVC insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.
IS:5831	:	Specification for PVC insulation and sheath of electric cables.
IS:8130	:	Specification for conductors for insulated electric cables and flexible cords.
IS:10810	:	Specification for methods of test for Cables.

Cables meeting with any other authoritative standards which ensures equal or better quality than the standards mentioned above will also be accepted.

3.0 CLIMATIC CONDITIONS :

3.1 The Control Cables called in this Specification are required to operate satisfactorily under the following climatic conditions.

1) Location	In the State of Andhra Pradesh
2) Maximum ambient Air Temperature (deg.C)	50
3) Minimum Ambient Air Temperature (deg C)	7.5
4) Average daily ambient air Temperature (deg. C)	35
5) Maximum relative humidity (%)	74
6) Maximum altitude above mean sea level (Meter s)	1000
7) Average annual rainfall (mm)	925
8) Maximum wind pressure (kg/sq.mtr)	200
9) Isoceraunic level (Days/Year)	50
10) Seismic Level (Horizontal Acceleration)	0.1g

4.0 MAIN FEATURES:

4.1 These general purpose insulation cables shall be suitable for use where the combination of ambient temperature and temperature rise due to load results in conductor temperature not exceeding

-- 70 deg. C for normal continuous operation
-- 160 deg. C for short circuit condition

4.2 The cables shall be suitable for laying in covered/open trenches, ducts, trays or buried directly underground under dry or wet conditions. Suitable additives to prevent attack by rodents, termites shall be added to the outer sheath PVC compound. Also, the outer sheathing shall be so designed as to afford high degree of mechanical protection besides making it resistant to heat, oils, chemicals, abrasion, weather conditions etc. Common acids, alkalis, contaminants saline solutions etc., shall not have adverse effects on the PVC sheathing material used.

4.3 The cables shall be capable of operating continuously under the system frequency variation of ±5% voltage variation of ±10% and a combined frequency - voltage variation of ±10%.

5.0 TECHNICAL REQUIREMENTS
5.1 CONDUCTOR
5.1.1 MATERIAL:

The conductor shall be composed of plain annealed copper wires (complying with IS:8130) made of high conductivity copper rods (complying with the latest version of IS:613).

5.1.2 FORM:

The conductors shall be circular, stranded. They shall be clean, reasonably uniform in size and shape, smooth and free from all harmful defects.

5.1.3 JOINTS:

Joints shall be permitted in the individual wires of which the conductor is formed but no joint shall be within 300mm of any other joint within the same layer. The joints shall be made by resistance butt welding, fusion welding, cold pressure welding, electric welding, gas welding, brazing or silver soldering.

5.1.4 Classification :

Class-2 for stranded circular non-compacted cables used for fixed installation.

5.1.5 SIZE, NUMBER, RESISTANCE:
The wires in the conductor shall have the same nominal diameter before stranding. The number of wires in the conductor shall be not less than 3 and the maximum resistance of conductor at 20 deg. C shall be 7.41 Ohms/km as per Table 2 of IS:8130.

5.2 INSULATION:

5.2.1 MATERIAL:

The insulation shall be "General Purpose Insulation" of Type-A PVC Compound (conforming to the requirements of IS-5831) suitable for a maximum rated conductor temperature of 70 deg C intended for cables with rated voltages up to and including 3.3 kV. The conductor shall be provided with this Type-A PVC insulation applied by extrusion.

5.2.2 COMPOSITION:

The insulation shall consist of a compound based on one of the following materials, which have been SUITABLY COMPOUNDED AND PROCESSED to meet the requirement of the IS:5831.

a) Polyvinyl chloride (PVC)
b) Suitable co-polymers of which the major constituent shall be vinyl chloride.
c) Mixture of (a) and (b)

5.2.3 TEST REQUIREMENT:

The insulation shall satisfy the test requirements stated in columns 2,3,4, & 7 of TABLE-1 of IS:5831.

5.2.4 THICKNESS:

The average thickness of insulation shall be not less than the nominal value (t1) of 0.9mm applicable for un armoured multicore cables of size 2.5 sq. mm as per Column 3 of Table 2 of IS:1554.

5.2.5 TOLERANCE ON THICKNESS:

The smallest of the measured values of thickness of insulation shall not fall below the nominal value (t1 i.e. 0.9mm) by more than 0.1mm + 0.1 t1.

5.2.6 APPLICATION:

The insulation shall be so applied that it fits closely on the conductor and it shall be possible to remove it without damage to the conductor.

5.3 CORE:

5.3.1 IDENTIFICATION:

Cores shall be identified by different coloring of PVC insulation by adopting the following scheme:

a) 2 cores : Red and Black
b) 4 cores : Red, Yellow, Blue & Black
c) 10 cores : As per IS:1554 (Part-1)-1988

5.3.2 ARRANGEMENT OF MARKING:

The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing "d" between consecutive numbers shall not exceed 50mm as shown in Fig.1 of IS:1554 (Part-1)-1988 Page-4 .

5.4 LAYING UP OF CORES:

In the twin and multicore cables, the cores shall be laid up together with a suitable lay; the outermost layer shall have right hand lay and the successive layers shall be laid with opposite lay, where necessary. The interstices shall be filled with non-hygroscopic material (discussed in Cl.5.5.1).

The following lay-up of core shall be applicable as recommended in Table-3 of the IS:1554 Part-1).

No. of cores	Lay-up
2	2
4	4
10	10

5.5 INNER SHEATH:

5.5.1 MATERIAL:

Inner sheath as well as filler material (discussed in Cl.3.5.4) shall be as follows:

a) Unvulcanised rubber or
b) Thermoplastic materials, or
c) Proofed tape (for inner sheath only)

Unvulcanised rubber or thermoplastic material used shall not be harder than the type-A PVC used for insulation and the Type Sl. 1 PVC used for outer sheath. The material shall be so chosen as to be compatible with temperature ratings of the cable and shall have no deleterious effect on any other component of the cable.

5.5.2 CONSTRUCTION:

The laid up cores shall be provided with inner sheath applied by extrusion only. It shall be ensured that the shape is as circular as possible. 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. The thickness of the inner sheath shall be 0.3mm minimum as specified in Col.3 of Table-4 of IS:1554, applicable for the multi core cables whose calculated diameter over laid up cores is up to and including 25mm. If and when one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as part of the inner sheath.

5.6 OUTER SHEATH:

5.6.1 MATERIALS:

For cables with general purpose insulation, the outer sheath shall be of Type ST-1 PVC compound conforming to the requirements of IS:5831 as recommended for general purpose sheath intended for use in cables operating at a maximum rated conductor temperature 70 deg C. Composition of the outer sheath shall be as specified in Cl.5.2.2 of this specification but the test requirements shall be as per Columns 2,3,4 & 6 of Table-2 of IS:5831.

5.6.2 CONSTRUCTION:

This outer sheath shall be applied by extrusion over the inner sheath as applicable for un armored twin and multi core cables. It shall be so applied that it fits closely over inner sheath and it shall also be possible to remove it without damaging the inner sheath. The color of the outer sheath shall be black.

5.6.3 THICKNESS:

The average and minimum thickness of the PVC outer sheath shall be not less than the values specified hereunder as per Col.3 & 4 of Table 7 of IS:1554.

Calculated diameter under the outer sheath		Thickness of outer sheath for un armoured cables.	
Over (mm)	Up to and including	Nominal (mm)	Minimum (mm)
---	15	1.8	1.24
15	25	2.0	1.40

NOTE: In case of multi core un armoured cables, it is permissible to supply the inner and outer sheaths in a single extrusion out of the material intended for outer sheath. The average/minimum thickness of such extruded sheath shall be not less than the sum of the inner sheath thickness specified (0.3mm) and the nominal/minimum outer sheath thickness specified above.

5.6.4 The guaranteed technical particulars for the material being supplied shall be provided with the bid as specified in the Annexure-I enclosed. The bid received without these particulars shall be treated as non-responsive and rejected.

6.0 TESTS:

6.1 TYPE TESTS:

6.1.1 All the control cables offered should have been fully type tested as per the relevant standards. The date of type tests conducted shall be the latest and not more than 5 years old. The bidder shall furnish two sets of type test reports along with the offer. The bids received without type test reports will be considered non responsive .

6.3 ACCEPTANCE TESTS:

The following shall constitute acceptance tests

a) Annealing test
b) Conductor resistance
c) Thickness of insulation and sheath
d) Tensile strength and elongation at break of insulation and sheath
e) Insulation resistance test
f) High voltage test at room temperature

The sampling plan for acceptance tests shall be as per Appendix-A of the IS:1554 (Part-1)

6.4 ROUTINE TESTS:

The following shall constitute routine tests:

a) Conductor resistance test
b) High voltage test at room temperature

6.5 OPTIONAL TESTS:

a) Cold bend
b) Cold impact

NOTE: i) For test methods, relevant parts of IS - 10819 shall be referred.
ii) The test certificates as a result of the inspection of the cables (pursuant to Clause 7 below), shall be furnished to the purchaser for his approval prior to despatch.

7.0 INSPECTION

7.1 The Purchaser's representative shall, at all times, be entitled to have access to the works and all places of manufacture where cable shall be manufactured and the representative shall have full facilities for unrestricted inspection of the Bidder's works, raw materials and process of manufacture and conducting necessary tests as detailed herein.

7.2 The Bidder shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of cable in its various stages so that arrangements can be made for inspection.

7.3 No material shall be despatched from its point of manufacture before it has been satisfactorily inspected and tested, or unless the inspection is waived off by the Purchaser in writing. In the later case also, the cable shall be despatched only after satisfactory testing for all tests specified herein has been completed and approved by the Purchaser.

7.4 The acceptance of any quantity of material shall in no way relieve the Bidder of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

7.5 At least 5% of the total number of drums subject to minimum of two in any lot put up for inspection, shall be selected at random to ascertain the length of cable by the following method:
"At the works of the manufacturer of the cable, the cable shall be transferred from one drum to another at the same time measuring its length with the help of a graduated pulley & Cyclometer. The difference in the average length thus obtained and as declared by the Bidder in the packing list shall be applied to all the drums if the cable is found short during checking."

7.6 The bidder shall give 15 days advance intimation to enable the purchaser to depute his representative for witnessing acceptance and routine tests. All the charges in connection with inspection by purchaser personnel such as travel, accommodation and incidentals shall be borne by the bidder.

8.0 QUALITY ASSURANCE PLAN :

8.1 The bidder shall invariably furnish the following information along with his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i) The Structure of organization
ii) The duties and responsibilities assigned to staff ensuring quality of work
iii) The system of purchasing, taking delivery and verification of materials
iv) The system for ensuring quality of workmanship
v) The quality assurance arrangements shall confirm to the relevant requirement of ISO-9001 on ISO 9002 as applicable.
vi) Statement giving list of important raw materials, names of sub-supplies for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in the presence of suppliers representative, copies of test certificates.
vii) Information and copies of test certificates as on (i) above in respect of bought out items.
viii) List of manufacturing facilities available
ix) Level of automation achieved and list of areas where manual processing exists.
x) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
xi) The List of testing equipment available with the bidder for final testing of equipment specified and test plant limitation, if any vis-a-vis the type. Special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in "Schedule of Deviations" from the specified test requirements.

8.2 The Contractor shall within 30 days of placement of order, submit the following information to the purchaser.

i) List of the raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.

ii) Type test certificates of the raw material and bought out accessories if required by the purchaser.

iii) Quality Assurance Plan (QAP) with hold points for purchasers inspection. QAP and purchasers hold points shall be discussed between the purchaser and contractor before the QAP is finalised.

The contractor shall submit the routine test certificates of bought out accessories and central excise asses for raw material at the time of routine testing if required by the purchaser and ensure that the quality assurance requirements of specification are followed by the sub-contractor.

8.3 The Quality Assurance Program shall give a description of the Quality System and Quality Plans with the following details.

i) Quality System:
   a) The Structure of the Organisation
   b) The duties and responsibilities assigned to staff ensuring quality of work.
   c) The system of purchasing, taking delivery of verification of materials.
   d) The system of ensuring of quality workmanship.
   e) The system of control of documentation.
   f) The system of retention of records.
   g) The arrangement of contractor internal auditing.
   h) A list of Administrator and work procedures required to achieve contractor's quality requirements. These procedures shall be made readily available to the purchaser for inspection on request.

ii) Quality Plans:
   a) An outline of the proposed work and program sequence.
   b) The structure of contractor's organizations for the contract.
   c) The duties and responsibilities ensuring quality of work
   d) Hold and notification points.
   e) Submission of engineering documents required by this specification.
   f) The Inspection of the materials and components on request.
   g) Reference to contractor's work procedures appropriate to each activity.
   h) Inspection during fabrication/construction.
   i) Final inspection and test.

9.0 DOCUMENTATION:

9.1 All drawings shall conform to International Standards Organization (ISO) "A" series of drawing sheets/Indian Standards Specifications. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units.

In addition to any other drawings which the tenderer may like to supply three sets of the followings drawings/manuals must be submitted with the tender.

i) Drawing showing sectional view of cables and cable drums

ii) Technical and descriptive literature giving details of the cables offered

iii) Tables of rating factor for correction of current rating for variation in standard condition of installation.

iv) Test facilities available at the tenderer's works.

9.2 TEST REPORTS:

i) Four copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned, duly certified by the purchaser and only thereafter shall the materials be dispatched.

ii) All records of routine test reports shall be maintained by the Bidder at his works for periodic inspection by the purchaser.

iii) All test reports of tests conducted during manufacture shall be maintained by the Bidder. These shall be produced for verification as and when requested for by the purchaser.

10. IDENTIFICATION, PACKING AND MARKING:

10.1.1 MANUFACTURER'S IDENTIFICATION:

The manufacturer shall be identified throughout the length of the cable by means of a tape bearing the manufacturer's name or trade mark, by being indented, printed or embossed on the outer sheath of the cable

10.1.2 CABLE IDENTIFICATION:

The words "AP-PDCL" shall be indented, printed or embossed throughout the length of the cable at frequent intervals (not more than 1 meter in any case) on the outer sheath. The cable shall be marked sequential numbers for each meter on outer sheath .

10.1.3 CABLE CODE:

Cable code shall be Y Y to indicate copper cable having PVC insulation with PVC outer sheath.

NOTE: No code letter for conductor when the conductor material is copper.

10.2.1 PACKING:

The cable shall be wound on a non-returnable wooden/steel drum (conforming to the latest version of IS:10810) of suitable size and packed. The ends of the cable shall be sealed by means of non-hygroscopic sealing material. The drum packing shall be robust enough for rough handling that may be subjected to during transit by water/rail /road. Type and material of the drum shall be specified by the Bidder by means of a dimensional drawing.

10.2.2 STANDARD DRUM LENGTHS AND QUANTITY TOLERANCE:

Each cable drum shall contain one SINGLE CONTINUOUS LENGTH. The desired drum lengths are as follows:

2Cx2.5 Sq.mm	-	1000 Mtrs. ±10%
4Cx2.5 sq.mm	-	1000 Mtrs. ±10%
10Cx2.5 sq.mm	-	1000 Mtrs. ±10%

Overall quantity tolerance shall be ±5% for each size.
The Purchaser reserves the right to alter the drum lengths, if required, while placing the order. The bidder may also offer the maximum drum lengths he is capable of supplying against each size.

10.3 DRUM MARKING:

"THE CABLE DRUM SHALL BE DULY "IS" MARKED" and carry the following details:

a) Reference to the "IS"
b) Manufacturer's name, brand name, trade name
c) Type of cable and voltage grade
d) Number of cores
e) Nominal cross-sectional area of the conductor (Sq.mm).
f) Color of cores
g) Length of the cable on the drum (Mtrs.)
of rotation of drum by means of arrow.
h) Approximate gross mass (Kg)
i) Running end of cable
j) Country of manufacturer and
k) Year of manufacture

11. GUARANTEED TECHNICAL PARTICULARS

The bidders shall furnish the guaranteed Technical particulars as per Annexure enclosed.

12. The tenderer shall furnish a copy of valid BIS licence for ISI marking together with their offer, without which the offer shall be treated as non-responsive.

ANNEXURE

STANDERDISED GURANTEED TECHNICAL PARTICULARS FOR UNARMOURED COPPER CONTROL CABLES

Sl. No.	Description	Parameters/Values			Details to be furnished by the bidder
1	Material Description	**CONTROL CABLES**			
2	a) Type and description of the cable with size	Copper conductor PVC Insulated un-armoured cables as per IS:1554(Part-I)			
	b) Standards which they conform to	IS : 1554 (P-I),IS 8130, IS : 5831			
	The type test should have been conducted not earlier than 5 years in the NABL accredited laboratory. The Manufacturer shall produce the type test reports at the time of acceptance tests.				
	c) Quality of material & standard to which conform	BIS			
	The Manufacturer shall produce the valid BIS certification at the time of acceptance tests.				
3	**CONDUCTOR (Sq.mm)**	2 C X 2.5	4 C X 2.5	10 C X 2.5	
	a) Material	Standard Copper Conductor as per IS : 8130			
	b) Whether Stranded	Yes			
	c) If so, number of strands (Approx)	7	7	7	
	d) Nominal Diameter of each strand before stranding (mm)	0.67	0.67	0.67	
	e) Max. resistance at 20 Deg.C (Ohms/kM)	7.41			
4	**INSULATION**				
	a) Material	PVC Type A as per IS : 5831			
	b) Nominal thickness (mm)	0.9	0.9	0.9	
	c) Minimum tensile strength without ageing (N/mm2) and maximum % variation after ageing	12.5 ± 20%			
	d) Minimum elongation at break without ageing (%) and maximum % variation after ageing.	150% ± 20%			
	e) Minimum volume resistivity at				
	i) 27 Deg C (Ohm -Cm)	1×10^{13}			
	ii) Max. rated temperature of 70 Deg.C (Ohm-Cm)	1×10^{10}			
	f) Minimum insulation resistance constant at				
	i) 27 Deg C (Mega ohm kM)	36.7			
	ii) Max. rated temperature of 70 Deg.C (Mega Ohm-kM)	0.037			
	iii) Whether application of insulation is way of extrusion.	Extrusion			

Sl. No.	Description	Parameters/Values			Details to be furnished by the bidder
5	**INNER SHEATH**				
	a) Material	PVC as per IS : 1554 (Part-1)			
	b) Minimum thickness of inner sheath (in mm)	0.3	0.3	0.3	
	c) Whether method of application is by way of extrusion	Extrusion			
6	**Interstices (or fillers)**				
	a) Whether used in the formation of cable	Yes			
	b) Material	PVC			
7	**OUTER SHEATH**				
	a) Material	PVC ST - 1 as per IS : 5831			
	b) Nominal thickness (mm)	1.8	1.8	2	
	c) Minimum tensile strength without ageing	12.5 ± 20%			
	d) Minimum elongation of break (%) and maximum variation after ageing (%).	150% ± 20%			
	e) Whether method of application is by way of extrusion.	YES Extrusion			
	f) Are the inner and outer sheaths extruded in a single operation out of the material intended for	As per IS :1554 (part-I)			
	g) Whether the PVC suitably treated for withstanding the working conditions.	YES			
	h) Colour	BLACK			
8	**Physical parameters**				
	a) Overall diameter of core (mm)	3.85	3.85	3.85	
	b) Calculated diameter over laid up core (mm)	7.7	9.3	15.4	
	c) Calculated diameter under the outer sheath (mm)	8.3	9.9	16	
	d)Overall diameter of the finished cable (mm)	11.9	13.5	20	
	Tolerance %	5%			
9	**Drum length (mtrs) / tolerance (%)**	1000 +/- 10% in general or as per the requirement in case of short lengths.			
	a) Approx. Cable weight (kG/kM)	200	277	610	
	b) Approx.Gross weight of the complete drum with cable (kG)	247	329	728	
10	**Electrical parameters**				
	a) Rated voltage (volts)	1100 Volts			
	b) Voltage grade (volts)	1100 Volts			
	c) Whether suitable for earthed/Unearthed system	Both			
	d) Continuous current carrying capacity (Amps)				
	i) In Air	27	24	24	
	ii) In ducts	27	24	24	
	ii) In ground	32	27	27	
	e) Short circuit current capacity for 1 sec.	284.5 Amps			
	f) Max. Conductor temperature during short circuit condition.	160. deg.C.			

Sl. No.	Description	Parameters/Values	Details to be furnished by the bidder
11	**Markings**	As per IS:1554(part-I)&"AP-PDCL to be indented, printed or embossed with an interval of one meter throughout the cable.	
12	**Identification**	Cores shall be identified by different coloring of PVC insulation by adopting the following scheme:	
		a) 2 cores : Red and Black	
		b) 4 cores : Red, Yellow, Blue and Black	
		c) 10 cores : As per IS	