

ANNEXURE-I



Technical Specification LT Power Cable



**Indian Oil Corporation Limited
Mathura Refinery
Instrumentation Department**



Annexure-I (Technical Specification)

LT Power Cable



1. GENERAL

This specification together with datasheets attached herewith covers requirements for design, manufacture, testing, inspection and supply of LT power, signal, control, earthing and thermocouple cables suitable for working voltages up to and including 1.1 KV grade.

2. CODES AND STANDARDS

The requirements shall be designed and manufactured in compliance with latest edition prior to the date of the purchaser's enquiry of the following applicable codes, standard practices and publications.

BS: 5308 (Part-1)/ 1986	Instrumentation Cables- Specification for polyethylene insulated cables
BS: 5308 (Part-2)	Specifications for PVC insulated cables.
IS: 3975	Low carbon galvanized steel wires, formed wires and tapes for armoring of cables.
BS: 5099	Spark Testing of electrical cables
IS: 1554 (Part-1)	PVC insulated electric cables for working voltages up to and including 1100V
IS: 5831	PVC insulation and sheath of electrical cables.
IS: 6380	Elastomeric Insulation and sheath of electric cables
IS: 6474	Polyethylene insulation and sheath of electric cables
PD2379	Register of colors of manufacturer's identification threads for electric cable and cords
IEC:540 & 540A	Test methods for insulation and sheaths of electric Cables
IEC:60331	Testing of Fire Resistant cables.
IEC:60332	Tests on bunched wires and cables.
IEC:60092	Electrical Installations of Cables
IEC:60754	Test on Gases Evolved during Combustion of materials from Cables - Part 1,2.
ASTM-D-2843	Standard test method for density of smoke from burning or decomposition of plastics
ASTM-D-2863	Standard method for measuring minimum oxygen concentration to support candle like combustion of plastics (Oxygen Index).
IS: 1554 Part 1	PVC insulated (heavy duty) electric cables-working voltage up to and including 1100V.
IS: 3975	Mild steel wires, formed wires and tapes for armouring of cables.
IS: 5831	PVC insulation and sheath of electric cables.
IS: 6380	Elastomeric insulation and sheath of electric cables
IS: 6474	Polyethelene Insulation and sheath of electric cables
IS: 10810	Method of test for cables
Part 40	Method for testing uniformity of coating on zinc coated articles.
Part 41	Mass of zinc coating on steel armour
Part 58	Oxygen Index test
Part 59	Determination of halogen acid gas evolved during combustion of polymeric material taken from cables
Part 61	Flame Retardant test
Part 62	Flame Retardance test for bunched cables



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Part 63	Smoke density of electric cables under fire conditions
Part 64	Measurement of Temperature Index
IS:8130	Conductors for insulated electrical cables and flexible cords
IS:10418	Specification for drums for electric cables. Parts- 40/41/58/59/61/62/63
IS:209	Specifications for Zinc.

2.1. In the event of any conflict between this standard specification, data sheets statutory regulations, related standards, codes etc., the following order of priority shall govern:

- Statutory Regulations
- Data Sheets
- Standard Specifications
- Codes & Standards

3. DESIGN AND CONSTRUCTION

- 3.1. Primary insulation for PVC insulated cables, shall be 85°C polyvinyl chloride Type C as per IS5831. Thickness of primary insulation shall be 0.5 mm as a minimum. For PE insulated cables, primary insulation shall be of 70 deg C Polyethylene.
- 3.2. Inner sheath color of signal cables shall be black. The outer sheath color for all signal cables shall be light blue. The thickness of the sheath shall be as per IS 1554 part 1.
- 3.3. Inner and outer sheath of cable shall be flame retardant made of extruded PVC Type ST2 (90°C)as per IS 5831 and shall meet the following requirements:
 - 3.3.1. Minimum Oxygen index of PVC shall be 30 at 27 deg C +/- 2 deg C.
 - 3.3.2. Temperature index shall be over 250 deg C.
 - 3.3.3. Inner and Outer sheath shall meet flame retardant requirements for bunched cables as per IS 108 10 (Part 62) category AF or IEC 60332 category A.
 - 3.3.4. A rip cord shall be provided for inner sheath.
 - 3.3.5. Outer sheath shall be suitable for protecting the cable against rodent and termite attack.
- 3.4. Armour over inner sheath shall be of galvanized steel wire/flat. The dimensions of armour shall be as per IS 1554 (Part 1). Requirement and methods of tests for amour material and uniformity of galvanization shall be as per IS 3975 and IS 10810 (Part 40) respectively.
- 3.5. Each pair/triad shall be shielded. Shield shall be of aluminum backed by Mylar / polyester tape bonded together helically applied with metallic side down having 25% overlap on either side and 100% coverage. Minimum shield thickness shall be 0.05 mm. Drain wire shall be 0.5 mm² multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminum side of the shield. An overall binder shall be provided with Rip Cord of non-metallic material under the inner sheath. In case of single pair/triad cables, they shall be only overall shielded.
- 3.6. Overall shield shall be of aluminum backed up by Mylar /polyester tape helically applied with the metallic side down with either side having 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075 mm. Drain wire shall be similar to individual pair/ triad drain wire and shall be over the overall shield.
- 3.7. The ends of the cable shall be sealed with suitable PVC/ Rubber caps to prevent ingress of moisture. Extra PVC / Rubber end caps for each cable size shall be supplied free of cost with a minimum of five per thousand-meter length.
- 3.8. The construction of the conductors shall be stranded annealed tinned electrolytic copper conductor of cross sections specified elsewhere. The copper shall have minimum 7 strands each of 0.53 mm diameter (for 1.5 mm² cable) and minimum 7 strands each of 0.67 mm diameter (for 2.5 mm² cable) conforming to relevant BS/ IS standards. For cables of more than 2.5mm² size, the conductor shall have minimum 7 strands each of suitable diameter conforming to relevant BS/ IS standards.
- 3.9. The cable cores shall be laid up with at least 10 uniform twists per meter complete with binder tapes applied



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over final layer of pairs as per BS:5308 (Clause-11).

- 3.10. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing /engraving/printing shall be legible and indelible.
- 3.11. Tolerance in overall diameter of cable shall be within ± 2 mm over offered value.
- 3.12. A drain wire of minimum 0.5 sq.mm (7X 0.3 mm) stranded, annealed, tinned copper wire shall be laid so as to be in continuous contact with the aluminum side of the shield. An overall binder shall be provided with Rip Cord of non-metallic material under the inner sheath.

4. SPECIFIC REQUIREMENTS FOR FIRE RESISTANT OR FIRE SURVIVAL CABLE

- 4.1. The cables shall have circuit integrity as per IEC 60331.
- 4.2. Primary insulation shall be heat resisting elastomeric which can withstand temperature up to 90°C such as silicon rubber/mica glass tape/EPR (medium grade) as per IS 6380. Insulation thickness shall be 1.0mm minimum (0.44 mm for Silicon rubber) and shall confirm to IEC 60092.
- 4.3. Individual pair triad shall be shielded. The shield shall be aluminum backed by Mylar/PETP tape with the metallic side down helically applied with 25% overlap on either side and 100% coverage. Minimum shield thickness shall be as per IEC 60092. Drain wire shall be 0.5mm² (7/0.3m diameter) multi-stranded bare tinned annealed copper conductor. Drain wire shall be in continuous contact with aluminum side of the shield.
- 4.4. Inner and outer sheath shall be made of low smoke, heat resistant, oil resistant and flame retardant material with oxygen index over 30, temperature index shall be over 250°C. Acid generation shall be maximum 20% by weight as per IEC 60754. Smoke density rating not to exceed 60% as per ASTM D 2843.
- 4.5. The thickness of the sheath shall be as per IEC 60092. Inner and outer sheath colour shall be orange. A rip cord shall be provided for inner sheath.

5. INDIVIDUAL CABLE SPECIFICATIONS AND ELECTRICAL CHARACTERISTICS

5.1. Electrical Characteristics

- 5.1.1. Maximum DC resistance of the conductor of the finished cable shall not exceed 7.41Ω/Km at 20°C for cables with 2.5 mm² conductors, 12.3 Ω/Km at 20°C for cables with 1.5 mm² conductors and 39.7Ω/Km at 20°C for cables with 0.5 mm² conductors.
- 5.1.2. Mutual capacitance for PVC insulated cables between pairs/ triads or adjacent cores shall not exceed 250 pF/ meter at a frequency of 1 KHz.
- 5.1.3. Mutual capacitance for PE/XLPE insulated cables between pairs/ triads or adjacent cores shall not exceed 100 pF/ meter at a frequency of 1 KHz.
- 5.1.4. Capacitance between any core and screen shall not exceed a maximum of 400 pF/ meter at a frequency of 1 KHz.
- 5.1.5. L/R ratio of adjacent core shall not exceed 40μH/Ω for cables with 1.5 mm² conductors, conductors and 25μH/Ω for cables with 0.5 mm² conductors.
- 5.1.6. The drain wire resistance including shield shall not exceed 30 Ω/Km.
- 5.1.7. Electrostatic noise rejection ratio of the finished cable shall be over 76 dB.

5.2. Power Cables

- 5.2.1. Each core shall be 2.5 mm² made of 07 stranded annealed tinned electrolytic copper conductor each of thickness 0.67 mm.
- 5.2.2. Color of core insulation shall be black, red in case of two core and yellow, red and blue in case of a three core.
- 5.2.3. All other specifications shall be as per the clauses 3.0 and 4.1 of this specification.



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5.3. Single pair/triad shielded Signal and Single pair Control cables.

- 5.3.1. Each core shall be 1.5 mm² / 2.5 mm² (as per the respective datasheet) made of 07 stranded annealed tinned electrolytic copper conductor each of thickness 0.53 mm / 0.67mm respectively.
- 5.3.2. Color of core insulation shall be black and blue in case of pair of signal cable / Black, Blue and Brown in triad / Black and White in pair for control cable.
- 5.3.3. All other specifications shall be as per the clauses 3.0 and 4.1 of this specification.

5.4. Multi- pair/triad cable with individual pair/triad shield & overall shield

- 5.4.1. Each core shall be 2.5 mm² / 1.5 mm² / 0.5 mm² (as specified in data sheets) made of 07 stranded annealed tinned electrolytic copper conductor each of thickness 0.67 mm / 0.53mm / 0.3mm respectively.
- 5.4.2. Overall twist of all pair/ triads shall be as per vendor's standard.
- 5.4.3. Color of core insulation of each pair /triad shall be black and blue in case of multi-pair of signal cable / Black, Blue and Brown in case of multi-triad cable.
- 5.4.4. A pair of communication wire shall be provided for multi pair cables. Each wire shall be 0.5 mm² of plain annealed single or multi-strand copper conductor 0.4mm thick 85°C PVC insulation. Insulation shall be green and red color coded.
- 5.4.5. Pair identification shall be with numbers and alphabets at interval of not more than 250 mm.
- 5.4.6. All other specifications shall be as per the clauses 3.0 and 4.1 of this specification.

5.5. Earthing Cables

- 5.5.1. Each core shall be 6mm² / 16mm² / 25mm² as per the datasheet made of 07 stranded annealed tinned electrolytic copper conductor each of thickness as specified in the datasheet.
- 5.5.2. Color of core insulation shall be green.
- 5.5.3. All other specifications shall be as per the clauses 3.0 and 4.1 of this specification.

6. CABLE & CABLE DRUM IDENTIFICATION

6.1. Cable shall be identified by embossing the following details at an interval of meter on the outer sheath of the cable: -

NO. OF ELEMENTS X SIZE- Type of Cable - Name of Refinery.

Name of the Manufacturer

Year of Manufacture

6.2. The identification of twisted multi-pair shall be by number printed polyester tape.

6.3. After completion of electrical tests the ends of the cable shall be sealed to prevent the ingress of moisture.

6.4. Each cable drum shall be marked with the following information at a visible place.

Manufacturer's name

Details of the cable e.g. "3C X 2.5 SQMM POWER CABLE- PVC FRLS"

Length of the cable (in meters) contained in the drum.

Gross weight

Direction of rotation of drum for unwinding shall be marked with an arrow.

Purchase order number.

6.5. The length of the cables in each drum (drum length) shall be as specified in the data sheets. Where no drum length is indicated in the data sheet, the cable drums shall be in lengths of 1000



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meters. The actual produced drum length shall not vary by more than +2.5% from the value indicated in the purchase order. No negative tolerance is allowed.

- 6.6. Cable dimensions furnished by the vendor in his bid shall be firm and vendor shall comply with all the values during execution.
- 6.7. Cables shall be dispatched in wooden drums, securely battened with takeoff end fully protected against damage.
- 6.8. Vendor shall dispatch the cables on clearance by TPI/ Owner's representative after witnessing the tests and successful completion of inspection of the cables.
- 6.9. Vendor shall submit 2 sets of complete inspection reports including test certificates etc. along with the consignment.

7. INSPECTION

- 7.1. After completion of manufacture of cables and prior to dispatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. IOCL reserves the right to witness all tests with sufficient advance notice from vendor. The Test reports for all cables shall be got approved from the IOCL Engg. before dispatch of the cables.
- 7.2. Vendor shall offer all cables for pre-dispatch inspection to TPI agency and following tests / checks shall be carried out as minimum:
 - 7.2.1. Acceptance tests as per clause 8.3 on representative samples.
 - 7.2.2. Review of all certificates and test reports as indicated in clause 7.0.
- 7.3. Immediately after completion of electrical tests, the ends of the cable shall be sealed to prevent ingress of moisture with suitable PVC / rubber caps.
- 7.4. Vendor to quote for Third Party Inspection also. The TPI agency should be approved by IOCL and Scope of inspection is as mentioned in clause 8.3.
- 7.5. Type test, routine test and acceptance tests shall be carried out as per relevant IS/ standards, unless specified otherwise.
- 7.6. In the event no witness inspection is carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

8. TESTING

8.1. Type Test:

Certificates from third party or client/ consultant's authorized representative for the following shall be furnished by vendor along with offer for cables similar to those being offered. Time period of validity of such Test Certificates shall be not more than 2 years.

- Flame retardant test to IEC 332-3 part 3 Cat A
- Electrostatic noise rejection test.
- Flammability test
- FRLS tests as per clause 7.3 below.

8.2. Routine Test:

Each of the following tests shall be carried out by vendor during various stages of manufacture; purchaser/ Third party inspection agency shall review the related documents.

- a. Insulation and jackets – All tests as per IS-5831.
- b. Insulation resistance, High voltage and spark test as per BS-5308 Part-2.
- c. Armor test as per IS-3975.
- d. Conductor resistance.
- e. Cable capacitance tests.



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- f. L/R ratio and inductance.

8.3. Acceptance test:

The following tests shall be carried out in the presence of purchaser/ Third party inspecting agency.

8.3.1. Test & witness on all drums

- 8.3.1.1. High Voltage test as per BS-5308 Part-2.
- 8.3.1.2. Conductor Resistance and drain wire resistance.
- 8.3.1.3. Insulation resistance test as per BS-5308 Part-2.

8.3.2. Test & witness on sample drums (Minimum 10% of the drums)

- 8.3.2.1. Visual/ dimensional/ constructional details.
- 8.3.2.2. Tensile strength and elongation at break of insulation and sheath.
- 8.3.2.3. Continuity test
- 8.3.2.4. Armor test as per IS-3975.
- 8.3.2.5. Cable capacitance, L/R ratio and inductance test.
- 8.3.2.6. Mutual capacitance and capacitance between any core or screen.
- 8.3.2.7. Thickness of insulation and sheath.
- 8.3.2.8. Pair twisting, laying and identification.
- 8.3.2.9. Shield overlap, drain wire resistance.
- 8.3.2.10. Tests for uniformity of galvanization of armor as per IS-2633.
- 8.3.2.11. Oxygen and temperature index test as per ASTM D2863.
- 8.3.2.12. Flame retardant test on single cable as per IS 10810 (Part-61)
- 8.3.2.13. Acid generation test IEC 60754 /IS 10810 (Part-59)
- 8.3.2.14. Smoke density test ASTM D 2843/ IS 10810 (Part 63)
- 8.3.2.15. Dimensional check for overall diameter and under armor/ over armor diameter.
- 8.3.2.16. Overall finish and check of drum length and overall length tolerances.

9. SPECIAL INSTRUCTIONS TO VENDOR

- 9.1. Duly filled, signed and stamped copy of the Technical Specification and datasheets shall be submitted by the vendor along with the offer as a token of their acceptance of the tender in totality without any deviation.
- 9.2. The specifications for cables have been provided in the datasheets in tender document. The standards given in the datasheet have been specified for each part of the cable and are applicable on each part separately as per datasheet and not on cable as a whole.
- 9.3. In case of any difference between RFQ text description, general specifications and datasheet, bidder to quote as per datasheet.
- 9.4. Deviations, if any, from the specifications, relevant codes & standards must be specified in the offer. If there are no deviations, bidder to indicate the same as "NO DEVIATIONS". In absence of any written deviation clearly specified in the offer, it will be considered that the offer is in line with the requirements & complied in totality of this document.
- 9.5. Vendor to submit detailed drawing, datasheet, catalogues and manuals to substantiate the specifications indicated by the purchaser along with the offer for Technical evaluation.
- 9.6. Vendor shall provide sample test certificates for all the tests indicated in clause 7.0 of these specifications with the offer. In addition, vendor shall provide the 'Manufacturer's certificate of conformity' to purchaser's specifications as per clause 2.2 of DIN 50049.
- 9.7. Vendor to submit soft copies of drawings, datasheets and Inspection reports to IOCL one week before dispatch of material for review/verification. A hard copy of the same shall be sent along with the supply of



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the material.

9.8. Bidder to submit Inspection Release Note (IRN), Test certificates for obtaining dispatch clearance and also as part of the supply of cables.

9.9. The owner reserves the right to reject or accept any tender without assigning any reasons whatsoever.

9.10. The technical offer shall be in following format only for ease of evaluation. Each section shall be separately segregated & highlighted with distinct Marker / Flags between the sections.

S/N	DESCRIPTION	BIDDER'S COMPLIANCE
a	Signed and stamped copy of complete specification. Vendor to fill values in vendor response column wherever it is required to be indicated, simply writing " noted /confirmed" in place of requirement of value is not acceptable.	
b	Deviations to specification if any shall be clearly listed under this section. If there are no deviations, vendor shall say "NO DEVIATIONS" under this section.	
c	Complete drawing, datasheet, catalogues, manuals and sample test reports of the offered cables shall be attached. Wherever asked to furnish details under the technical specifications, the same shall be included in this section.	

10. DOCUMENTATION

10.1. Post Order Documents to be submitted by the bidder for review/ approval.

DOCUMENTATION REQUIREMENT	Review/Approval
QUALITY ASSURANCE PLAN (QAP)	For Approval
PRODUCTION PROGRAMME	For Review
DATA SHEETS	For Approval
Detail GAD / INSTALLATION DRAWINGS	For Approval
BILL OF MATERIALS	For Approval

10.2. Schedule of submission of the above documents shall be aligned to meet the delivery requirements.



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11. DATASHEET

Specification for 3C * 2.5 Sq.mm Power Cables

SAP CODE: 7715620504

S.No.	CATEGORY	DESCRIPTION	SPECIFICATION	Bidder compliance- Please specify values wherever applicable
1	GENERAL	No. of Cores, Cross Section	3Cx2.5 Sqmm	
		Reference Standards	As per attached general specifications in Annexure-II F	
		Voltage Grade	1.100 KV	
		Make	Vendor to specify	
2	CONDUCTOR	Type	Annealed Bare Copper Conductor as per IS:8130 class2	
		Cross Section (nom.)	2.5 Sq. mm	
		Strand diameter	0.67 mm	
		No. of Strands	7 Nos	
3	INSULATION	Insulation Type	Extruded HR-PVC['Type C of IS:5831/1984] 85degC as per IS:5831	
		Thickness (nom.)	As per IS 1554 part-1(in mm)	
		Core identification	Red, Black & Green	
4	INNER SHEATH	Rip cord	Required	
		Sheath Material	Extruded, HR PVC ST2 (90 degC) FRLS as per IS:5831	
		Thickness (min.)	As per IS 1554 part-1	
		Colour	Black	
5	ARMOUR	Armour Type	Galvanised steel wire as per IS 3975	
		Thickness of wire	As per IS 1554 part-1(in mm)	
		Direction	left hand	
		Dia over armour	11.6 +/- 2 mm	
6	OUTER SHEATH	Sheath Material	Extruded, HR PVC ST2 (90 degC) FRLS as per IS:5831 Anti rodent & anti termite properties	
		Thickness min.	As per IS 1554 part-1(in mm)	
		Dia Approx.	14.4 +/- 2mm	
		Colour	Black	
		Marking	No. of cores x Sqmm,armoured FRLS cable, 1100V, Mtr PO NO & Date ,Manufacturer name etc	



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7	ELECTRICAL PARAMETER	Conductor Resistance (At 20 degC)	7.56 Ohm/Km
		High Voltage Test	3 KVAC for 5 Minute
		Insulation resistance min	100 Mohm/Km
8	FRLS TEST	Min. Oxygen Index as per ASTM -2863	30%
		Min. Temp. Index as per ASTM -2863	250 DegC
		Max.Acid gas generation as per IEC-754-1	20%
		Max. Smoke density rating as per ASTM 2843	60%
		Flammability test	IEC 60332-1
9	PACKING	Each Drum Cable Length	1000 Meter
		Mode-Spool/Drum/Coil	wooden Drum
10	TPI	Third Party Inspection	Required. In Vendor's Scope