Reliance
Industries Limited

J3 PROGRAM

JAMNAGAR, INDIA

DOCUMENT TITLE:

Standard Specification for LV Power and Control Cables

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RECORD OF REVISIONS

Date	Revision Details	Revision Number
This specification is prepared referring document number EPCMD- 1-SS-EL-022 Rev0		
19.07.12	Issued for Implementation	0
25.01.2013	Clause 2 : Scope revised Clause 8.2 : Added "Suitable for Hydrocarbon processing facility" Clause 8.5.1.2:“Power cables of all voltage grades with conductor size 6 mm2 and above shall have XLPE insulation.” Changed to “All cables of all voltage grades shall have XLPE insulation.” Removed “Low voltage power cables <6mm2 size shall have PVC insulation.” Added requirement for Special metal deactivation additives (antioxidant compound) in XLPE insulation. Clause 8.5.1.5: Removed “In case of single core armoured cables, there shall be extruded inner sheath between insulation and armouring.” Clause 8.6.1: "non-returnable wooden/ steel drums" changed to "non-returnable wooden/ returnable steel drums". Clause 8.6.3: Removed "Positive tolerance is at seller's discretion, but will not be reimbursed by buyer." Clause 10: Format of bullet and numbering changed Clause 10.3: Removed “Wafer Boil test for XLPE cables as per ASTM-2765” from Type Tests Changed "Ageing in Air" to "Ageing in air oven" Clause10.4: Removed “Gel content test as per ASTM-2763” from optional tests	1

Contents

1. Purpose

This document details the standard specifications for LV power and control cables and is issued for design.

2. Scope

This Standard specifies requirements for Low Voltage (for working voltage up to and including 1100V) single core/multi core, copper/aluminum conductor, XLPE/PVC insulated, armoured/unarmoured Power and Control Cables for use in petroleum, petrochemical and gas industry process services.

Fire services cables and Cables suitable for variable voltage variable frequency application are excluded from the scope of this specification.

3. Cost competitive engineering and design

The engineering team shall maintain the cost focus throughout all phases of the project. This should be done without compromising any specification and design requirements.

4. Conflicts and Deviations

In the event of direct conflict between various order documents, the precedence of authority of documents shall be as follows:

- Cable Datasheet(s)
- Purchase Requisition
- This Standard Specification
- Reference standards

The supplier shall bring any conflict to the notice of the buyer or owner in writing and obtain a resolution to the conflicting requirements in writing during the quotation stage.

5. Definitions:

For the purposes of this document, the following terms and definitions apply:

Client: Reliance Industries Ltd., or other Reliance subsidiary companies, for whom these cables are being procured.

6. Abbreviations:

FRLS	Flame Retardant Low Smoke
PVC	Poly Vinyl Chloride
SWA	Steel Wire Armoured

AWA	Aluminium wire armour for single core cables
XLPE	Cross Linked Poly Ethylene

7. Codes and Standards:

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

7.1. IEC Standards

IEC 60228	Conductors of insulated cables. Guide to the dimensional limits of circular conductors.
IEC 60287	Calculation of the continuous current rating of cables (100% load factor)
IEC 60331	Tests for electric cables under fire conditions
IEC 60332	Tests on electric and fiber cables under fire conditions. Part 3-10 : Test for vertical flame spread of vertically-mounted bunched wires or cables - Apparatus, Part 3-21 : Test for vertical flame spread of vertically-mounted bunched wires or cables - Apparatus - Category A F/R
IEC 60502	Power Cables with Extruded Insulation and Their Accessories for rated voltage from 1kV (U_m = 1.2kV) Up To 30kV (U_m= 36kV), Part 1: Cables for rated voltages of 1 kV (U_m = 1,2 kV) and 3 kV (U_m = 3,6 kV)
IEC 60754	Test on gases evolved during combustion of materials from cables. Part 1: Determination of halogen acid gas content evolved during combustion of polymeric material taken from cables.
IEC 60811	Common test methods for insulating and sheathing materials of electric cables.
IEC 60885	Electric test methods for electric cables.
IEC 60304	Standard colours for insulation for low frequency cables and wires.
IEC 60227	PVC insulated cables of rated voltages up to and including 450/750 V.
IEC 61034	Measurement of smoke density of electric cables burning under defined conditions.

IEC 60028	International Standard of Resistance for Copper
IEC 60949	Calculation of thermally permissible short circuit currents, taking into account of non-adiabatic heating effects.

7.2. Indian Standards

IS 1554 Part 1	PVC insulated (heavy duty) electric cables for working voltages up to and including 1100V
IS 3975	Mild steel wires, formed wires and tapes for armouring of cables.
IS 5831	PVC insulation & sheath of electric cables.
IS 6474	Polyethylene insulation & sheath of electric cables.
IS 7098 Part 1	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
IS 8130	Conductors for insulated electric cables and flexible cords.
IS 10810	Methods of test for cables.
IS 10418	Specification for drums for electric cables

7.3. ASTM Standards

ASTM—D-2843	Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics
ASTM—D-2863	Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM—D-7567	Standard Test Method for Determining Gel Content in Cross linked Ethylene Plastics Using Pressurized Liquid Extraction
ASTM—D-2765	Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross linked Ethylene Plastics

7.4. ISO Standards

ISO 9000	Quality Management and Quality Assurance Standards
ISO 9001	Quality Systems – Model for Quality Assurance in Design /Development, Production, Installation and Servicing
ISO 9003	Quality System Model for Quality Assurance in Final Inspection and Test.

7.5. Other Standards

DIN-53387	Artificial weathering and ageing of plastics and elastomers by exposure to filtered xenon arc radiation.
SS 424-1475	Standard for flammability test

7.6. Project Standards

10080-1-DBD-GE-001	Basic Engineering Design Data (BEDD)
10080-1-DBD-EL-001	Electrical Design Basis

8. Basic Design:

8.1. Cables shall be suitable for use in a saliferous, sulphurous and dusty atmosphere. Condensation, solar radiation and wind loading etc. as per Basic Engineering Design Data (BEDD) 10080-1-DBD-GE-001 shall be taken into account.

8.2. All cables shall be suitable for installation on:

- Above ground fastened to cable racks or trays in the open air exposed to direct sunlight.
- Suitable for Hydrocarbon processing facility
- Direct buried in the ground (including water / chemical logged ground).
- In Underground ducts.
- Below ground in enclosed air filled trenches, fastened to cable racks or tray.

8.3. The design ambient temperature shall be considered as 43ºC, unless otherwise specified in the datasheet(s). The relative humidity shall be considered as 100%. The cables shall be suitable for operation in a fully tropical atmosphere.

8.4. Cables shall be suitable for the electrical system characteristics indicated in the data sheet. The system voltage and frequency variations shall be as given below:

Voltage: ± 10%

Frequency: ± 3%

Cables for AC service shall be suitable for operation at frequency of 50Hz.

Requirement of cables for DC service will be specified in the datasheet.

8.5. Cable Construction

8.5.1. Cable construction shall be as detailed under:

8.5.1.1. Conductor

The conductors shall be composed of plain copper or aluminum Wires complying with IS 8130.

Aluminum used for conductor shall be Electrolytic grade Aluminum, stranded, grade H4, Class 2 as per IS 8130.

Copper used for conductor shall be made from high conductivity copper rods complying with IS 613.

The conductor shall be stranded and either compacted circular or sector shaped for all LV cables.

Conductors upto & including 4sqmm shall be stranded annealed copper. Conductors above 4 sqmm and upto & including 10sqmm shall be solid / stranded aluminum. Conductors above 10 sqmm shall be stranded aluminum unless otherwise specified in the cable datasheet or Purchase requisition.

8.5.1.2. Insulation

All cables of all voltage grades shall have XLPE insulation. Cables shall conform to the properties covered in the applicable standards.

Special metal deactivation additives (antioxidant compound) shall be added to XLPE used with copper conductors. This shall be confirmed during bidding stage and test certificate from XLPE insulation vendor indicating above shall be provided during detail engineering for confirmation.

Insulation shall be suitable for rated voltage and conductor temperature of 90^0 C continuously rated current and 250^0C in case of short circuit condition as per IEC 60502 Part 1.

8.5.1.3. Core Identification

Following colour coding shall be acceptable for all cables upto four cores. Cables with more than four cores shall have printed numerals on each core.

- 1 Core : Black
- 2 Core : Red and Black

- 2 Core + Earth: Red, Black and Green/Yellow
- 3 Core : Red, Yellow and Blue
- 4 Core : Red, Yellow, Blue and Black
- 5 or more cores - numbered (Black numbers printed on grey coloured insulation)

8.5.1.4. Fillers

Filler materials used to fill up the interstices space between the power cable cores, under the inner sheath shall be Polypropylene fillers, such that the transmission of gas and hydrocarbons along the length of the cable, under normal pressure is not possible and shall prevent / reduce the water propagation through the cable.

8.5.1.5. Inner Sheath

Inner sheath when specified shall be PVC applied by extrusion and shall be compatible with the insulation provided for the cables. Plastic binder tape shall be provided as per IS 7098 - part I.

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. Minimum thickness of inner sheath shall be as per IS 1554 (part-1) for PVC insulated cables and IS 7098 (part-1) for XLPE insulated cables.

The inner sheath shall conform to the requirements of type ST1 compound of IS 5831 for PVC insulated cable and type ST2 compound of IS 5831 for XLPE insulated cables. The extruded inner sheath shall be of uniform thickness.

8.5.1.6. Armour

Armouring for the cables shall comprise galvanized steel or hard drawn aluminum, in the form of round wires or strips as indicated in the datasheet. Minimum area of coverage of armouring shall be 90%. The gap between any two armour strip/wire shall not be more than width of strip/diameter of armour. Type, dimension, resistance of armour shall be according to applicable standards mentioned herein.

For multi-core cables, the armouring shall be by galvanized steel strips / round wire as per IS 1554 (part-1) for PVC insulated cables and IS 7098 (part-1) for XLPE insulated cables. If armouring is specified for single core cables in the datasheet, the same shall be of non-magnetic material. Fault level calculation for armour shall be submitted.

8.5.1.7. Outer Sheath

The outer sheath of the cables shall be applied by extrusion over the armouring and shall be of PVC compound conforming to the requirement of type ST1

compound of IS 5831 for PVC insulated cable and type ST2 compound of IS 5831 for XLPE insulated cable.

The sheath shall be resistant to water, ultra violet radiation, fungus, termite and rodent attacks. The colour of the outer sheath shall be black unless otherwise specified in datasheet or under notes in datasheet.

The outer sheath shall be Flame Retardant Low Smoke type.

The outer sheath of cables shall be embossed or engraved with:

The voltage designation

Manufacturers identification

Number of Cores and nominal cross sectional area of conductors

The drum progressive length of cable at every meter. (The starting point being the cable end at its inner coil on the cable drum.)

8.6. General

8.6.1. Cables shall be supplied in non-returnable wooden/ returnable steel drums of suitable barrel diameter, securely battened with take-off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage. Cable drums shall conform to IS 10418 (Specification for drums of electric cables).

8.6.2. PVC/Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand metre length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.

8.6.3. Negative tolerance on cable length of cable drums is not acceptable.

8.6.4. Cable ends shall be sealed and fixed to the drum so that both ends are accessible. To protect the cable during shipment battens shall be fitted around the entire periphery of the drum. Drums shall be suitable for long term outdoor storage at site.

8.6.5. All cable drums shall have the Purchase Order Number, Purchase Order Item Number, Drum Number and Cable Code clearly stenciled on the outside of both flanges. The cable drum number shall be stenciled on each side of drum in 50mm high letters as minimum.

8.6.6. Drum identification labels shall be of non-corrosive, non-hygroscopic material and attached to the outside and inside of the drum flanges. Labels shall be protected by transparent plastic envelopes and give the following information:

- Reference of IEC or IS
- Drum identification number and its direction of rotation for cable removal.
- Cable voltage grade
- Cable construction (e.g. XLPE SWA PVC)
- Number of cores and cross sectional area
- Cable quantity (Meters)
- Purchase order number and item number
- Total weight of cable and drum (kg)
- Manufacturer's name
- Country & Year of manufacture
- Cable code

8.7. Life

8.7.1. Cables shall have a minimum design lifetime of 20 years.

9. Accessories:

Not Applicable for this Specification.

10. Inspection and Testing:

Cables shall be subjected to routine and acceptance tests in accordance with standards specified. Test methods shall conform to IS 10810 (Methods of Test for Cables).

Cables offered shall be of type tested quality. Type tests shall be performed in accordance with latest relevant standard in recognized national / international laboratory. Manufacturer shall ensure use of calibrated test equipment having valid calibration test certificates from standard laboratory traceable to National / International Standards.

10.1. Routine Tests

Routine tests shall comprise of the tests listed below as a minimum.

- Insulation Resistance Test
- Conductor Resistance Test
- High Voltage Power frequency withstand Test at room temperature
- Dimensional Check

10.2. Acceptance test

Acceptance tests shall comprise of the tests listed below as a minimum.

- Annealing test for copper
- Tensile test for Aluminum
- Wrapping test for Aluminum
- Conductor resistance
- Test for thickness of insulation and sheath
- Hot set test for insulation
- Tensile strength and elongation at break of insulation and sheath
- High voltage test
- Insulation resistance (volume resistivity)

10.3. Type Tests

Type tests shall comprise of the tests listed below as a minimum.

- Tests on conductor
  - Annealing test for copper
  - Tensile test for Aluminum
  - Wrapping test for Aluminum
  - Conductor resistance
- Test for armouring wires / stripes
- Test for thickness of insulation and sheath
- Physical tests for insulation
  - Tensile strength & elongation at break
  - Ageing in air oven
  - Hot set test
  - Shrinkage test
  - Water absorption (Gravimetric)
- Physical tests for outer sheath
  - Tensile strength & elongation at break
  - Ageing in air oven
  - Loss of mass in air oven

- Hot deformation
- Shrinkage test
- Heat shock test
- Thermal stability test

- High Voltage Test
- Insulation Resistance (Volume resistivity test)
- Oxygen Index
  - The critical oxygen index value shall be minimum 29 when tested at 27+2^{o}C as per ASTM-D-2863.
- Flammability (wherever applicable)
- Cables shall pass test under fire conditions as per IS-10810- Part-53.
- Cables shall also pass tests as per IS-10810 Part- 61 & Part-62 (CAT-AF).
- Test for Smoke Generation (where applicable)
  - The maximum smoke density rating shall not be more than 60% when tested as per ASTM-D-2843.
- Tests for Acid Gas Generation
  - The hydrochloric acid generation when tested as per IEC 60754-1 shall be less than 20% by weight.
- Tests for Resistance to Ultra Violet Radiation
  - This test shall be carried out as per DIN 53387. The retention values of tensile strength and ultimate elongation after the tests shall be minimum 60% of tensile strength and ultimate elongation before test.
- Temperature Index as per ASTM-D-2863.
  - The temperature index value shall be minimum 250^{o}C at oxygen index of 21 when tested as per ASTM-D-2843.
- Swedish Chimney test as per SS 424-1475
- Anti rodent & Termite repulsion test
- Tests for Water Absorption check (Gravimetric)

10.4. Optional Tests

Optional tests shall comprise of the tests listed below as a minimum.

- Cold bend test for outer sheath

- Cold impact test for outer sheath

11. Preparation for shipment:

- Preparation of shipment shall be made after all inspection & testing of the cables has been accomplished and equipment has been released for shipping by the Purchaser.
- Preparation for shipment shall protect the cable against corrosion, dampness, heavy rain and breakage during transportation or handling.
- Each shipping container shall be clearly identified with the contents, purchase order number and item number.
- Handling and storage instructions shall be supplied along with the package.

12. Vendor Data Requirement:

Following documents are at a minimum to be submitted to the client in soft copy format.

12.1. Along with the bid

Following documents shall be submitted along with quotation

- Duly filled cable data sheet.
- Inspection and test plan.
- Valid Type test certificates for the cables from CPRI or equivalent and sample routine test certificate.
- Details of manufacturer's quality assurance programme, ISO9000 series or equivalent national certification.
- Descriptive literature giving technical detail of the product offered.
- Reference list of supplied cables during the last five years.
- List of deviations if any.

12.2. During Manufacturing

Following documents as a minimum shall be submitted against the Purchase order.

- Quality Assurance Plan.
- Factory Acceptance Test Procedure / Routine Test Procedure.
- Calculations for short circuit capacity for each size
- Duly filled cable data sheet

- Certificate indicating all the cables supplied against the purchase order comply with this SPECIFICATION and all the relevant codes and standards.
- Type Test Certificates.
- Cross sectional drawings showing dimensions, arrangement of cores, weight, etc.

12.3. With the supplied material

- Inspection Test report
- Type test certificates
- Approved cable data sheets
- User manual

13. Attachments:

Not Applicable for this Specification.