Reliance
Industries Limited

Reliance
Project Management Group

Reliance Project Management System

Standard Specification for
LV Power and Control Cables
RPMS-ENGG-SPC-EL-022

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1. Scope

This specification defines the minimum technical requirements for design, material, manufacture, inspection, testing, packaging, shipment and documentation for LV Power and Control Cables (for working voltage up to and including 1100V) for Supplier and /or Contractor to comply with, to achieve Owner`s objective of standardization.

Fire Survival cables and Special cables for Variable voltage variable frequency applications are excluded from this specification.

Supplier and/or Contractor may propose adoption of standards of proven past references in similar service conditions. Owner will review, evaluate and approve deviations to this standard specification that Supplier and/or Contractor may seek on this account, prior to execution of Project Purchase Order.

2. References

The LV Power and Control Cables shall be designed, manufactured, assembled and tested in accordance with the latest applicable sections of the code and standards detailed in Appendix A.

Additional project specifications, as applicable to items of equipment, shall be detailed in the Material Requisition.

3. Conflicts and Deviations

In the event of conflict or deviation from requirements stipulated in this specification and other applicable documents, the following order of precedence shall govern:

a) Data Sheets

b) The Material Requisition

c) This Standard Specification

d) Codes and Standards Specifically Referred

e) Other National & International Standards as Referenced

Latest revisions of codes and other statutory requirements as applicable at the time of enquiry, shall be applicable. In case of any conflict, the decision of owners engineer in charge shall be final and seller shall implement that without any commercial implications. All “local and statutory requirements as applicable shall be complied to without any deviation”.

Notes:

- "Data sheets" represent those attached to the Material Requisition – Cables data sheets, Cable Stock code item description,

4. Abbreviations & Definitions

ASTM	American Society for Testing and Materials
AWA	Aluminium wire armour
DIN	Deutsches Institut für Normung
FRLS	Flame Retardant Low Smoke
PVC	Poly Vinyl Chloride
SWA	Steel Wire Armoured
XLPE	Cross Linked Poly Ethylene

Definitions

Parties responsible for complying with an Engineering Standard

Supplier	Party which manufactures or supplies equipment and services to perform the function as specified by Buyer
Buyer	Owner (Reliance) or Owner-appointed DEC or EPC who specifies equipment and services for purchase from Supplier

Parties referred within body of Engineering Standard

Owner	Reliance Industries Limited or specified Reliance Group Company
DEC	Detailed Engineering Contractor
EPC	Engineering, Procurement and Construction Contractor
Contractor	DEC or EPC

5. Technical and Design Requirements

5.1. Cables shall be suitable for use in site conditions as mentioned in data sheet. Cable shall have minimum design life of 25 years.

5.2. Cable shall be suitable and rated for electrical system characteristics as indicated in the data sheet and Electrical design basis

5.3. All cables shall be suitable for installation on:

a) Above ground fastened to cable racks or trays in the open air exposed to direct sunlight

b) Suitable for Hydrocarbon processing facilities like Petrochemical and Refinery

c) Direct buried in the ground (including water / chemical logged ground)

d) In Underground duct banks

e) Below ground in enclosed air filled trenches, fastened to cable racks or tray

f) Below ground trenches filled with sand

5.4. The design ambient temperature shall be considered as 43^0 C, 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. Cable shall be suitable for use in saline, sulphurous, dusty atmosphere as commonly encountered in oil refineries, chemical plants or other facilities. Condensation, solar radiation and other conditions shall be considered as stated in data sheet.

5.5. Cable Construction

5.5.1. Cable construction shall be as detailed under:

5.5.1.1. Conductor

a) The conductors shall be composed of plain copper or aluminum Wires complying with IS 8130.
b) Aluminum used for conductor shall be Electrolytic grade Aluminum, stranded, grade H4 and Class 2 as per IS 8130.
c) Copper used for conductor shall be made from high conductivity copper rods complying with IS 613.
d) The conductor shall be stranded and either compacted circular or sector shaped for all LV cables. Conductor shall have circular cross section for sizes up to and including 10 sq.mm and of sector shape for sizes above 10 sq.mm No. of wires in a conductor shall be as per IS: 8130.
e) Conductors up to & including 6 sq.mm shall be stranded annealed copper. Conductors above 6 sq.mm shall be stranded aluminum, unless specified otherwise in the datasheet or Material Requisition.

5.5.1.2. Insulation

a) All cables of all voltage grades shall have XLPE insulation except Earthing cables. Earthing cables shall have PVC insulation. The insulation shall be applied over conductor by extrusion process only.
b) Special metal deactivation additives (antioxidant compound) shall be added to XLPE used with copper conductors. This shall be confirmed during bidding stage. Test certificate from XLPE insulation Supplier indicating above shall be provided during detail engineering.
c) XLPE Insulation properties at rated voltage, rated current and under thermal conditions arising out of continuous operations at conductor temperature of 90^0 C and 250^0 C under short circuit conditions shall be as per IEC 60502 Part 1. In case of PVC insulation, it shall be suitable for continuous conductor temperature of 70^0 C and Short circuit conductor temperature of 160^0 C as per IEC 60502 Part 1.

5.5.1.3. Core Identification

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

a) 1 Core : Black
b) 2 Core : Red and Black
c) 2 Core + Earth: Red, Black and Green/Yellow
d) 3 Core : Red, Yellow and Blue
e) 4 Core : Red, Yellow, Blue and Black
f) 5 or more cores - numbered (Black numbers printed on grey coloured insulation)

5.5.1.4. Fillers

Non-hygroscopic filler materials used to fill up the interstices (space between the power cable cores, under the inner sheath) shall be Polypropylene. Further, it shall be such that the transmission of gas and hydrocarbons along the length of the cable, under normal pressure is not possible and shall prevent the water propagation through the cable. Fillers shall be compatible with the temperature rating of the cables and shall have no harmful effects on other components of cable.

5.5.1.5. Inner Sheath

a) Inner sheath, 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.
b) 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.

c) 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.
d) Single core cables shall have no inner sheath.

5.5.1.6. Armour

a) 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.
b) 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 or diameter of armour. Type, dimension and resistance of armour shall be according to applicable IS 7098- Part I.
c) The joints in the armour wires or strips shall be avoided in completed cable on the drum.
d) For multi-core XLPE insulated cables, the armouring shall be by galvanized steel strips or round wire as per IS 7098 (part-1). If armouring is specified for single core cables in the datasheet, the same shall be of non-magnetic material.
e) Mass and uniformity of zinc coating of round wires & strips shall be as per IS 4826 and IS 3975 respectively. Test certificates conforming to the standards mentioned shall be submitted during detailed engineering.

5.5.1.7. Outer Sheath

a) 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 for PVC insulated cable and type ST2 for XLPE insulated cable as per IS 5831.
b) The sheath shall be resistant to water, ultra violet radiation, fungus, termite and rodent attacks. The color of the outer sheath shall be black unless otherwise specified in data sheet
c) The outer sheath shall be Flame Retardant with reduced Halogen evolution and smoke (FR-LSH) as per IS 7098 Part 1, Appendix A.
d) The outer sheath of cables shall be embossed or engraved with:
    i. The Voltage grade designation
    ii. Supplier's identification
    iii. Number of Cores and nominal cross sectional area of conductors
    iv. Cable insulation Type
    v. Year of manufacturing
    vi. The drum progressive length of cable at every meter. (The starting point being the cable end at its inner coil on the cable drum.)

5.6. General

5.6.1. 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.

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

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

5.6.4. Sealed cable ends shall be 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.

5.6.5. There shall be proper labelling on cable drum, which 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:

a) Reference of IEC or IS

b) Drum identification number and its direction of rotation for cable removal.

c) Cable voltage grade

d) Cable construction (e.g. XLPE SWA PVC)

e) Number of cores and cross sectional area

f) Cable quantity (mtrs.)

g) Purchase order number and item number

h) Total weight of cable and drum (kg)

i) Supplier's name

j) Country & Year of manufacture

k) Cable code

6. Inspection and Testing

Cables shall be subjected to routine and acceptance tests in accordance with IS 7098 Part I and IS 1554 -Part I. 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. Supplier shall ensure use of calibrated test equipment having valid calibration test certificates from standard laboratory traceable to National / International Standards. Type test certificates shall not be older than 5 years.

6.1. Routine Tests

Routine tests shall comprise of the tests listed below as per IS 7098-Part 1, Clause No 15.3 and IS 1554 Part 1, Clause No 15.3 for XLPE and PVC insulated cables respectively as a minimum.

a) Conductor Resistance Test

b) High Voltage Test

Besides above listed tests, following inspection and tests to be performed

a) Dimensional Check

b) Insulation Resistance Test

6.2. Acceptance test

Acceptance tests shall comprise of the tests listed below as per IS 7098- Part I, Clause No: 15.2 and IS 1554 Part 1, Clause No 15.2 for XLPE and PVC insulated cables respectively as a minimum.

a) Annealing test (for copper)

b) Tensile test (for Aluminum)

c) Wrapping test (for Aluminum)

d) Conductor resistance test

e) Test for thickness of insulation and sheath

f) Hot set test for insulation

g) Tensile strength and elongation at break test for insulation and sheath

h) High voltage test

i) Insulation resistance (volume resistivity) test

6.3. Type Tests

Type tests shall comprise of the tests listed below as per IS 7098- Part 1, Clause No: 15.1 and IS 1554 Part 1, Clause No 15.1 for XLPE and PVC insulated cables respectively as a minimum.

a) Tests on conductor
    i. Annealing test (for copper)
    ii. Tensile test (for Aluminum)
    iii. Wrapping test (for Aluminum)
    iv. Resistance

b) Test for armouring wires / stripes

c) Test for thickness of insulation and sheath

d) Physical tests for insulation
    i. Tensile strength & elongation at break
    ii. Ageing in air oven
    iii. Hot set test
    iv. Shrinkage test
    v. Water absorption (Gravimetric)

e) Physical tests for outer sheath
    i. Tensile strength & elongation at break
    ii. Ageing in air oven
    iii. Loss of mass in air oven
    iv. Hot deformation
    v. Shrinkage test
    vi. Heat shock test
    vii. Thermal stability test

f) High Voltage Test

g) Insulation Resistance (Volume resistivity test)

h) Flammability Test

The following shall constitute cables additional Type Tests for improved fire performance compatibility

a) Oxygen Index test

b) Flame retardance test on single cable

c) Flame retardance test on bunched cables

d) Test for specific optical density of smoke

e) Smoke density

f) Test for halogen acid gas evolution

g) Temperature index

Besides above listed tests, following additional tests to be performed

a) Oxygen Index

i. The critical oxygen index value shall be minimum 29 when tested at $27+2^0$ C as per ASTM-D-2863.

b) Test for Smoke Generation (where applicable)

i. The maximum smoke density rating shall not be more than 60% when tested as per ASTM-D-2843.

c) Tests for Acid Gas Generation

i. The hydrochloric acid generation when tested as per IEC 60754-1 shall be less than 20% by weight.

d) Tests for Resistance to Ultra Violet Radiation

i. 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.

e) Temperature Index as per ASTM-D-2863.

ii. The temperature index value shall be minimum 250^oC at oxygen index of 21 when tested as per ASTM-D-2863.

f) Swedish Chimney test as per SS 424-14-75

g) Anti-rodent & Termite repulsion test

6.4. Optional Tests

Optional tests shall comprise of the tests listed below AS PER is 7098- Part I, Clause No, 15.4 and IS 1554 Part 1 , Clause No 15.4 for XLPE and PVC insulated cables respectively as a minimum.

a) Cold bend test for outer sheath

b) Cold impact test for outer sheath

7. Supplier Data

Documents to be submitted along with quotation and post order shall be as per the below list provided.

Sl. No	DESCRIPTION	Along with Quotation	Post Order
1	Duly filled cable data sheet(s).	√	√
2	Inspection and test plan	√	√
3	Inspection Test report		√
4	Valid Type test certificates for the cables from CPRI or equivalent and sample routine test certificate	√	√
5	Details of Supplier's quality assurance Programme, ISO9000 series or equivalent national certification	√	√
6	Descriptive literature giving technical detail of the product offered	√	√
7	Reference list of supplied cables during the last five years	√	√
8	List of deviations, if any	√	√
9	Quality Assurance Plan		√
10	Factory Acceptance Test Procedure / Routine Test Procedure		√
11	Calculations for short circuit capacity for each size		√
12	Conformance certificate indicating all the cables supplied against the purchase order comply with this Specification and all the relevant codes and standards.		√
13	Cross sectional drawings showing dimensions, arrangement of cores, weight, etc.		√
14	Certificates of the bought-out items and raw materials		√
15	Cable derating factors in aboveground, Underground (direct buried and in duct bank) and other installed conditions	√	√
16	Detailed cable catalogues		√

8. Packing, Preservation, Shipment and Storage

- 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 Buyer.
- 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.

Appendix A: Codes and Standards

IEC Standards

IEC 60028	International Standard of Resistance for Copper
IEC 60227	PVC insulated cables of rated voltages up to and including 450/750 V.
IEC 60228	Conductors of insulated cables
IEC 60287	Calculation of the continuous current rating of cables (100% load factor)
IEC 60304	Standard colours for insulation for low frequency cables and wires.
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 61034	Measurement of smoke density of electric cables burning under defined conditions.

Indian Standards

IS 613	Copper Rods and Bars for Electrical purposes
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.

BIS IS 3961 : PART 6 : 2016	Recommended Current rating for Cables Part 6 Cross linked Polyethylene insulated PVC sheathed cables
IS 4826	Specification for Hot dipped Galvanized coatings on Round wires
IS 5831	PVC 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

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-2765	Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross linked Ethylene Plastics

ISO Standards

ISO 877-1	Plastics -- Methods of exposure to solar radiation -- Part 1: General guidance

Other Standards

DIN-53387	Artificial weathering and ageing of plastics and elastomers by exposure to filtered xenon arc radiation.
SS 424-14-75	Standard for flammability test

Project Standards

RPMS-ENGG-DBD-PS-001	Basic Engineering Design Data (BEDD)
RPMS-ENGG-DBD-EL-001	Electrical Design Basis