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TECHNICAL SPECIFICATION FOR LOW TENSION POWER CABLES

1.0 INTENT OF SPECIFICATION:

1.1 This specification governs the requirements of design, manufacture, testing packing at manufacturer's work and delivery at site and complete in all respects of this specification.

2.0 APPLICABLE STANDARDS:

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest versions of below standards.

IS 1554-1 :	Specification for PVC insulated (Heavy duty) Electric Cables.
IS 209 :	Specification for Zinc
IS-8130 :	Conductors for insulated electric cables and flexible cords.
IS 3975 :	Standard for Mild steel wires, strips & tapes for Armoring.
IS 10810(Pt-41):	Method of test for cables: Mass of zinc coating on steel armour.
IS 10462(Pt-1) :	Fictitious calculation method for determination of Dimensions of Protective coverings of cables: Part-1 Electrometric and thermoplastic insulated cables.
IS 10418 :	Drums for electric cables.
IS 10810(Pt-58):	Oxygen Index test.
IS 10810(Pt-61):	Flame Retardant test.
IS 10810(Pt-62):	Fire resistance test for bunched cables.
IEC 60332-3 :	Tests on electric cables under fire conditions.
ASTM-D2863 :	Standard for critical oxygen index and temperature index test.
ASTM-D2843 :	Standard for smoke generation test.
IEC-754-1 :	Standard for Acid gas generation test.
IEC-332-1 :	Standard for Flammability test.
SS 424 1475 Class F3 :	Standard for Flammability test.
IEEE 383 :	Standard for type test of class IE electric cables, field splices, and connections for Nuclear power generating stations.
IS 5831 :	Standard for PVC Insulation & Sheath of electric cables.
IS 3961(Pt-2) :	Recommended current ratings for Cables
NEMA – WC 70:	Standard for Non-shielded power cables rated 2000Volts or less for the distribution of electrical energy.
NEMA – WC 53:	Standard test methods for extruded dielectric power, control, instrumentation and portable cables for test.
DIN 53387:	Artificial weathering and ageing of plastics and elastomers by exposure to Filtered Xenon arc radiation
ASTM-G-154:	Standard practice for operating fluorescent light apparatus for UV exposure of non-metallic materials.
BS: 7846:	Electric cables -600/1000V armoured fire resistant cables having thermosetting insulation and low emission of smoke and corrosive gases when affected by fire.

The cables shall also conform to the provisions of Indian electricity rules and other statutory regulations as applicable.

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3.0 CABLE REQUIREMENTS:

a) Voltage grade : 1100 V

b) Conductor: The conductors shall be High conductivity annealed plain Copper (Cu) and shall be compact and stranded. Conductors of nominal area less than 16sq.mm shall be circular only. Conductor of nominal area 16 sqmm and above may be circular or shaped Class 2 as per IS 8130.

c) Insulation: The core insulation shall be with HR PVC compound applied over the conductor by extrusion and shall confirm to the requirements of type 'C' compound as per IS: 5831. It shall be free from voids and shall withstand all mechanical and thermal stress under steady state and transient operating conditions. The thickness of insulation and the tolerance on the thickness of insulation shall be as per Table 2 of IS: 1554-I. Core identification shall be provided by colour coding. as per IS 1554-I.

d) Inner sheath : The inner sheath shall be applied over the laid up cores with filler between the cores wherever necessary and shall be of HRPVC FRLSH compound by extrusion and shall conform to the requirements of type ST 2 compound of IS: 5831. The extruded inner sheath shall be of uniform thickness. The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS:5831.

e) Armouring: Galvanized single round steel wire armor for twin and multicore cables. Requirement and methods of tests for armor material and uniformity of galvanization shall be as per IS -3975, IS -10810 (Part-41).

f) Outer sheath: The outer sheath of the cables shall be applied by extrusion over the armoring and shall be of HRPVC FRLSH compound conforming to the requirements of type ST 2 compound of IS: 5831. The minimum and average thickness of outer sheath for unarmored cables and minimum thickness of outer sheath for armored cables shall be as per IS: 1554-I. Suitable chemicals shall be added into the PVC compound of outer sheath to protect the cable against rodent and terminate attack. Outer sheath shall have following properties:

(i) Oxygen index of min. 29 (as per IS 10810 Part-58).
(ii) Acid gas emission of max. 20% (as per IEC-754-1).
(iii) Smoke density rating shall not be more than 60% (as per ASTMD-2843).

g) The thickness of the insulation, inner sheath & outer sheath shall be governed by values given in IS: 1554-I. The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

h) The overall diameter of the cables shall be strictly as per the values declared by the vendor in the technical information subject to a maximum tolerance of ±2mm up to overall diameter of 60mm and ±3mm for beyond 60mm.

i) The gap between armour wires / formed wires shall not exceed one armour wire/ formed wire space and there shall be no cross over / over-riding of armour wires / formed wires. The minimum area of coverage of armoring shall be 90%. The breaking load of armour joint

shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wires / formed wires.

j) Cable identification shall be provided by embossing on every meter on the outer sheath the following:
   i. UPRVUNL
   ii. Manufacturer's name or trademark
   iii. Voltage grade
   iv. Year of manufacture
   v. Type of insulation and sheath, e.g. HRPVC/HRPVC FRLSH as applicable.
   vi. No. of core and size of cables.
   vii. Sequential length marking at an interval of 1m through out the length of the cable.
   viii. ISI mark
   ix. Type of improved fire performance, e.g. FRLSH.

4.0 TESTS:.

4.1 The Cables shall be subjected to Type, Routine, Acceptance tests and Special tests as detailed below. BHEL/End User reserves the right to witness all tests with sufficient advance notice from vendor.

4.2 QUALIFICATION REQUIREMENT:
Cables offered shall have valid Type test certificates of recognized testing house such as CPRI, CMRI, PTB, BASEEFA, UL or equivalent. Type test certificates for the type tests as per IS 1554-I, & IS 5831 and other applicable standards, of not older than 5 years (prior to date of technical bid opening of this tender) issued by any recognized laboratory shall be furnished.

4.3 The cables shall be tested and inspected at the vendor's works. All the materials employed in manufacture of the cable shall be subjected, both before and after manufacture, to examination, testing and approval by BHEL/End User.

4.4 Vendor shall furnish all necessary information concerning the supply to BHEL.

4.5 The inspector shall have free access to the vendor's works for the purpose of inspecting the process of manufacture in all its stages and will have the power to reject any material, which appears to be of unsuitable description or of unsatisfactory quality.

4.6 The vendor shall give at least 15 days advance notice to the purchaser, regarding the date of testing to enable him or his representative to witness the tests.

4.7 Tests during manufacture:
During the manufacture of cables, manufacturer's standard tests shall be performed and record / test report shall be made available to purchaser's representative during inspection / testing.

4.8 TYPE ROUTINE & ACCEPTANCE TESTS:-
After completion of manufacture of cables, type, routine and acceptance tests shall be performed strictly as per relevant IS & other applicable standards amended upto date. Routine tests shall be carried out on 100% drums.

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4.9 TYPE TESTS :-

4.9.1 The type test as per applicable standards and as given below shall be conducted on one drum selected on random basis out of every 10 drums or less of each type and size of cable. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc. In case, facilities of any of the type tests are not available at the works of the supplier, then such type tests shall be carried out by the supplier at independent recognized Govt. approved laboratory at the cost of supplier. If in-house test facilities are to be used then the testing equipment shall be calibrated (valid calibration certificates shall be produced during inspection) and traced back to National Calibration standards. The reports shall be submitted for BHEL's approval before dispatch of the cables. There shall not be any delivery and commercial implications on account of this.

1. Conductor Resistance test as per IS:8130.
2. Test for armour wire/strip as per IS:3975
3. Test for thickness of Insulation and HRPVC, FR-LSH sheath :-
4. Tensile strength and elongation test for insulation & sheath :-
5. Ageing test for insulation and sheath:-
   The method of test shall be as per the relevant IS standard. The period of test shall be 168 hours (7 days). At the end of the ageing period, the tensile strength and elongation test shall be carried out as per Sr.No.(4) above.
6. Loss of mass test for HRPVC, FR-LSH sheath :-
   This test shall be carried out as per IS 583/1984 012 IEC 540 & IEC 502, on cables of all voltage grades. The maximum permissible loss of mass is 2 mg/sq.cm for PVC.
7. Shrinkage test for insulation & HRPVC FR-LSH sheath:-
   This shall be carried out as per IS:5831 — 1984 for sheathed
8. Hot deformation test for HRPVC,FR-LSH sheath :-
   This shall be carried out as per IS:5831 / 1984.
9. Cold Impact test for HRPVC,FR-LSH sheath :-
   This shall be carried out as per IS:5831.
10. Heat shock test for HRPVC,FR-LSH sheath :-
    This test shall be carried out as per IS 5831 / 1984 and IEC 540 and IEC 502 & sheath shall pass the requirements of this test.
11. Thermal stability test for HRPVC,FR-LSH sheath :-
    This test shall be carried out on cables as per IS 5831 / 1984 and IEC 540 and cables shall pass the minimum requirements of 80 minutes for sheath.
12. Test for bleeding and blooming of Pigments for HRPVC,FR-LSH Sheath
    This shall be carried out as per IS:5831 / 1984.
13. Fire Resistance Test
    This test is compulsory and shall comply with the relevant clause of applicable IS.
14. Insulation Resistance / Volume resistivity -
15. High Voltage Test
16. Test for Rodent & Termite Repulsion Property of Sheath :-
    A few chipping of the PVC compound is slowly ignited on a porcelain dish or cubicle in a muffle furnace at about 60 degree C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). Place a drop of aqueous sodium sulphide solution on a

thick filter paper and allow to soak. Touch the spot with a drop of above extract. A black spot indicates the presence of lead, the anti-termite and rodent compound.

17. Impulse Withstand Test

4.9.2 The normal sequence of the electrical tests shall be as per Clause 16.1.1 of IEC-502/1978 and / or as per applicable IS standard. All the tests listed herein shall be applied successively to the same sample.

4.9.3 The inner and outer sheath shall be subjected to all the tests applicable for PVC sheath as per IS 5831 / 1984.

4.10 SPECIAL TESTS ON HRPVC 'FR-LSH' MATERIAL

All the sizes of power cables of the 'FRLS' HRPVC sheathed type shall pass following special test requirements. Inner sheath wherever applicable shall also be of the 'FR-LSH' type 'HRPVC' to meet these special tests.

i) Oxygen/Temperature Index test on sheath material :-

This test shall be carried out as per American National Std. A STM-D-2863/77.

The minimum oxygen index shall be 29 at room temperature.

For determination of the temp.index, the oxygen index test shall be carried out at different temperature upto 250°C. However, the test shall be carried out by extra-polation method beyond temperature at which the material of sheath may start deformation. The minimum temp. index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.

ii) Acid gas emission test on sheath material :-

This test shall be carried out as per IEC Std. 754-1. The maximum acid gas emission shall be less than 20 by weight.

iii) Smoke density test on sheath material :-

This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). The ASTM test method is compulsory. For passing this test, the requirement of light transmission shall be minimum 40% after the test.

iv) Flammability test on finished cable sample :-

This test shall be carried out as per the following method :

Swedish Std.SS:424-14-75 Class-F3. This test known as Swedish Chimney test is compulsory.

IEEE std. 383-1974 — This test known as the vertical tray flame propagation test shall be conducted if insisted by purchaser.

IEC Std: 332-1. — The cable should meet the requirement of all the above standards.

4.11 ROUTINE TESTS :

The following tests shall be carried out as Routine tests on each and every drum length of cable,

- High Voltage Test
- Conductor Resistance Test

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4.12 ACCEPTANCE TEST :

The following test shall be carried out as Acceptance Test in the presence of UPRVUNL Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturer's/supplier's cost.

1. High Voltage Test
2. Conductor Resistance Test
3. Tensile / wrapping test.
4. Partial discharge test (In screened cables).
5. Insulation Resistance/Volume resistivity test
6. Measurement of thickness of insulation and sheath and other dimensions
7. Tensile strength & elongation at break for insulation & sheath.
8. Flammability test as per Swedish standard SS:424-15-75 Class-F-3 (Swedish Chimney test)
9. Acid gas generation test as per IEC-754-1.
10. Smoke density test as per ASTM-D-2843/1977
11. Oxygen index test as per ASTM-D 2863/1977
12. Temp. index test as per ASTM-2863/77

5.0 <u>PACKING AND DESPATCH:</u>

5.1 Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction as per relevant IS. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden drums shall be treated by immersing in copper nitrate solution.

5.2 Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose.

5.3 The cables shall be supplied in non-returnable packing wooden drums for 1100V power cables which shall contain 1000 meters length of cable. A tolerance of +3 %(No Negative tolerance) shall be permissible for each drum and overall quantity. However, the supplier will be required to obtain approval before packing the Cables on drums.

5.4 A label shall be securely attached to each end of the reel indicating the length, type, voltage grade, conductor size and number of core of the cable. A tag containing the same information shall be attached to the leading end of the cable inside. An arrow and necessary instructions shall be marked on the drum indicating the direction in which it should be rolled. Drum numbers are to be indicated on cable drums.

5.5 The cable drums should carry the following details in printed form (non returnable):

a) UPRVUNL & Manufacturer's name or trade make
b) Type of cable & voltage grade
c) Year of manufacture
d) Type of insulation / sheath e.g. HRPVC /HRPVC FRLSH as applicable.
e) No. of core and size of cables
f) Cable code
g) Length of cable on drum

h) Direction of rotation, by arrow
i) Approx. gross mass.
j) ISI mark
k) IS/IEC number

5.6 PVC/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.

5.7 The total length of the cable against each material code to be supplied by vendor as per BHEL enquiry. Further if any additional length required for conducting tests as per BHEL specification shall be considered by vendor over and above the length mentioned in the BHEL enquiry.

5.8 The spare order quantity shall be packed and dispatched separately by vendor

6.0 DOCUMENTATION:

6.1 DRAWINGS, DATA AND MANUAL:

6.1.1 To be submitted along with bid

a. Technical data sheets (just for information). Datasheets as per relevant formats given shall be furnished. Separately typed vendor datasheets are NOT acceptable.
b. Type Test Reports
c. Bidder shall furnish Deviation Schedule.
d. Check list for Bid Submission.

6.1.2 To be submitted in 6 sets after award of contract

Sl.No.	Description
1.	Completely filled in technical data sheets as per relevant formats given shall be furnished. Separately typed vendor datasheets are NOT acceptable.
2.	Transport/Shipping dimension drawing
3.	Type Test Reports
4.	Erection manual
5.	Catalogues

No. of copies to be submitted for each submission shall be as follows

- For Approval & Review documents shall be in 6 copies.

7.0 GENERAL:

Based on the actual requirement, quantity can be increased / decreased by about 10% on overall qty. Unit rates shall be applicable for the revised BOQ also.

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8.0 DEVIATION SCHEDULE

Enquiry No.:
Name of Bidder:
Offer Ref. No.:

DEVIATION FORMAT

Sl. No.	Clause no. & Spec. no.	Description as per Specification	Deviation taken	Nature of Deviation	Remarks

NOTES:

1. **Technical offer of the bidder will be evaluated only on the basis of Deviation Schedule. Deviation Schedule constitutes this sheet (with these Notes) duly signed and stamped.**
2. Deviations, if any, shall be clearly brought out only in this format. Deviations mentioned / taken elsewhere or in any other format will be ignored.
3. Additional sheets in the same format can be attached by the vendor, if necessary.
4. Nature of Deviations shall only be of Design / Manufacturing constraints and non-availability of items / components / makes in market.
5. No price implications shall be entertained for deviations withdrawn during the technical scrutiny. If any deviations are accepted by BHEL during technical scrutiny then also there will be no price implication. Hence, in no case there will be consideration of Price implications.
6. Reasons for the deviations shall be specified in the Remarks column.
7. If there are no deviations from the specifications, bidder still has to submit the Deviation Schedule by writing “NO Deviations” in this format.
8. If the “Deviation Schedule” is not submitted along with the offer, the bidder’s offer is likely to be rejected without any further interaction with the bidder.
9. Only the accepted deviations in conjunction with the original tender shall constitute the contract document for the award of job to the bidder.

SIGNATURE OF BIDDER _____

NAME _____

DESIGNATION _____

COMPANY SEAL **DATE** _____

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9.0 CHECKLIST FOR BID SUBMISSION

(TO BE FILLED BY BIDDER AND SUBMITTED ALONG WITH OFFER)

Sl. No.	Description	Bidder Confirmation	Comments/ Remarks
1	Technical offer is conforming to technical specification PY55406, Rev00 & its associated Annexures (if any), pre-bid clarifications (if any) etc., Bidder to confirm (Yes / No).		
2	Bidder confirms that they have read the provisions of the Deviation Schedule and have included the deviation Schedule in the Offer after agreeing to the said Provisions (Yes/No).		
3	Bidder confirms that Prices for all items have been Quoted. Unpriced & Priced Schedules are included in the Techno-commercial Offer and Priced Offer respectively. (YES/NO)		
4	Bidder confirms that all the tests (routine, acceptance, type, special tests) and additional tests (if any) will be conducted as per the specification. (YES/NO)		
5	As per specification, bidder confirms that complete set of valid type test reports not older than 5 years (prior to date of technical bid opening of this tender) have been included along with the offer. (YES/NO)		

Notes: Offer received without affirmative confirmation against any of the above points may not be considered for evaluation.

(Signature and stamp of bidder with date)

TABLE-1 - MATERIAL CODIFICATION:

Var. No	No. of cores & Sizes (Sq.mm.)	Armouring	Cond, Insulation &Outer sheath matl.	BHEL Material Code
00	2CX2.5	Armoured	Cu. Cond. HRPVC Insulation /FRLSH HRPVC Cable	PY9855406001

List of Annexures:
Guidelines to Vendors for Preparation of Quality Assurance Plan

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TECHNICAL DATA SHEET

S.No. Description

1. Cable size
2. BHEL material code
3. Cable code
4. Applicable standards:
5. Name of vendor
6. Voltage Grade
7. Maximum conductor temperature under Normal operating conditions :
8. Maximum conductor temperature under Short circuit conditions :
9. Permissible voltage variation:
10. Permissible frequency variation:
11. Combined voltage & frequency variation
12. **Conductor** :
    a. Conductor material :
    b. Size (sq.mm) Nominal(Main/Neutral)
    c. No.of wires & diameter of each wire (No/mm)
    d. Shape of conductor
    e. aximum DC resistance of conductor at 20deg.C
13. **Insulation:**
    a. Insulation Material
    b. Insulation Type
    c. Extruded (Yes/No)
    d. Thickness of insulation(Nominal)(mm)(Main/Neutral) :
14. Core identification:
15. Calculated dia over laid up cores:
16. Inner sheath :
    a. Material
    b. Type
    c. Minimum Thickness
    d. Extruded: Yes.
    e. Calculated diameter of cable under armour(as per IS:10462) :
17. Armouring :
    a. Material :
    b. Type of armour :
    c. Nominal dia of armour:
    d. No.of armour wires/strips:
    e. DC resistance of armour
18. Nominal diameter of cable under outer sheath :
19. Calculated diameter of cable under outer sheath :
20. Outer sheath :
    a. Material
    b. Type
    c. Minimum Thickness:

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d. Extruded: Yes

21. Nominal outer diameter of cable :
22. Calculated outer diameter of cable:
23. Tolerance on outer diameter :
24. Electrical parameters:
    a. AC resistance at 90 deg.C:
    b. Cable reactance:
    c. Cable impedance:
25. Short circuit rating of conductor for the Duration of 1 sec(kA)
26. Maximum drum length of cable:
27. Continuous current rating for standard IS conditions laid direct (amps)
    a. In ground (ground temp of 30 deg.C)
    b. In duct (ground temp of 30 deg.C)
    c. In air (ambient temp of 40 deg.C)
28. Embossing on outer sheath:
29. Total I2R losses(watts/meter/phase), When cable laid in ground.
30. No. of end caps:
31. Tests to be conducted:
32. Current carrying capacity(in air at 40˚C) :
    (in ground at 30˚C)
33. Derating factor for cable current carrying : carrying for different method of laying
34. Minimum Bending radius:
35. Weight of the cable per meter(Kg)

RECORD OF REVISIONS				
Rev. No.	Date	Revision Details	Revised	Approved
00	27.04.2020	Original Issue	-	(-Sd/-) Saroj Kumar

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