4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

## 5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

## 6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

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# B - 2

# MOTORS

| | |
|---|---|
| LARA SUPER THERMAL POWER PROJECT, STAGE-I (2X800 MW)<br>DARLIPALI SUPER THERMAL POWER PROJECT, STAGE-I (2X800 MW)<br>GAJMARA SUPER THERMAL POWER PROJECT, STAGE-I (2X800 MW)<br>KUDGI SUPER THERMAL POWER PROJECT, STAGE-I (3X800 MW)<br>STEAM TURBINE GENERATOR PACKAGE | TECHNICAL SPECIFICATION<br>SECTION-VI<br>PART-B |

| CLAUSE NO. | TECHNICAL REQUIREMENTS | एनटीपीसी NTPC |
|---|---|---|
| | **MOTORS** | |
| **1.00.00** | **GENERAL REQUIREMENTS** | |
| 1.01.00 | For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment. | |
| 1.02.00 | All equipments shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification. | |
| 1.03.00 | Contractor shall provide fully compatible electrical system, equipments, accessories and services. | |
| 1.04.00 | All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations. | |
| 1.05.00 | The auxiliary AC voltage supply arrangement shall have 11kV, 3.3 kV and 415V systems and DC voltage shall be 220 V. It shall be designed to limit voltage variations as given below under worst operating condition :<br>(a) 11kV, 3.3 kV +/- 6%<br>(b) 415/240V +/- 10%<br>(c) 220 V DC -15% to +10%. However the nominal continuous DC power supply shall be 242V. | |
| 1.06.00 | The voltage level for motors shall be as follows :-<br>a) Upto 0.2KW : Single phase 240V AC / 3 phase 415V AC<br>b) Above 0.2KW and upto 200KW : 3 phase 415V AC<br>c) Above 200KW and upto 1500 KW: 3.3 kV<br>d) Above 1500 KW : 11 kV | |
| 1.07.00 | Fault level shall be limited to 40kA RMS for 1 second for 11kV & 3.3 kV system and 45 kA RMS 1 second for 415V system. 415V system shall be solidly grounded and 220 VDC system shall be isolated type. | |
| 1.08.00 | Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment. | |
| 1.09.00 | The responsibility of coordination with electrical agencies and obtaining all necessary clearances shall be of the contractor. — S.No - 117/Amdt-1/4 | |

| CLAUSE NO. | TECHNICAL REQUIREMENTS | एनटीपीसी NTPC |
|---|---|---|
| 1.10.00 | Degree of Protection<br><br>Degree of protection for various enclosures as per IS:4691, IEC60034-05 shall be as follows :-<br><br>i) Indoor motors - IP 54<br>ii) Outdoor motors - IP 55<br>iii) Cable box-indoor area - IP 54<br>iv) Cable box-Outdoor area - IP 55 | |
| **2.00.00** | **CODES AND STANDARDS**<br><br>1) Three phase induction motors : IS:325, IEC:60034<br>2) Single phase AC motors : IS:996, IEC:60034<br>3) Crane duty motors : IS:3177, IEC:60034<br>4) DC motors/generators : IS:4722<br>5) Energy Efficient motors : IS 12615, IEC:60034-30 | |
| **3.00.00** | **TYPE** | |
| 3.01.00 | **AC Motors:**<br><br>a) Squirrel cage induction motor suitable for direct-on-line starting.<br><br>b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be Energy Efficient motors, Efficiency class-Eff 1, conforming to IS 12615, or High efficiency (IE2) as per IEC:60034-30.<br><br>c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement. | |
| 3.02.00 | DC Motors Shunt wound. | |
| **4.00.00** | **RATING**<br><br>(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.<br><br>(b) Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven | |



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|---|---|
| | equipment under entire operating range including voltage and frequency variations. |
| | (c) For BFP motors starting MVA shall be restricted to 80 MVA. S.no-118 Amdt-1/4 dtd 25/8/1 |
| **5.00.00** | **TEMPERATURE RISE** |
| | **Air cooled motors** |
| | 70 deg. C by resistance method for both thermal class 130(B) & 155(F) insulation. |
| | **Water cooled** |
| | 80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for both thermal class 130(B) & 155(F) insulation. |
| **6.00.00** | **OPERATIONAL REQUIREMENTS** |
| 6.01.00 | **Starting Time** |
| 6.01.01 | For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time. |
| 6.01.02 | For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time. |
| 6.01.03 | For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time. |
| 6.01.04 | Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met. |
| 6.02.00 | **Torque Requirements** |
| 6.02.01 | Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque. |
| 6.02.02 | Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors. |
| 6.03.00 | **Starting voltage requirement** |
| | (a) 85% below 110 KW |
| | (b) 80% from 110 KW to 200 KW |

(c) 85% above 200 KW to 1000 KW

(d) 80% from 1001 KW to 4000 KW

(e) 75% above 4000KW

Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.

**7.00.00 DESIGN AND CONSTRUCTIONAL FEATURES**

7.01.00 Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors , space heater terminals inside the main terminal box may be acceptable.

7.02.00 All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below

(a) Fuel oil area : Group – IIB

(b) Hydrogen generation :Group - IIC (or Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)

7.03.00 Winding and Insulation

(a) Type : Non-hygroscopic, oil resistant, flame resistant

(b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature.

(c) 11kV & 3.3 kV AC motors : Thermal class 155 (F) insulation.
The winding insulation process shall be total Vacuum Presure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15

(d) 240VAC, 415V AC & 220V DC motors : Thermal Class( B ) or better

7.04.00 Motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

| CLAUSE NO. | TECHNICAL REQUIREMENTS |
|---|---|
| 7.05.00 | Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature. |
| 7.06.00 | Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. |
| 7.07.00 | In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and preferably 2 numbers duplex platinum resistance type temperature detectors. |
| 7.08.00 | Motor body shall have two earthing points on opposite sides. |
| 7.09.00 | HT motors can be offered with either elastimould termination or dust tight phase separated double walled (metallic as well as insulated barrier) cable boxes. In case elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided. In case cable box is offered, then Employer shall provide termination kit. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes. |
| 7.10.00 | The spacing between gland plate & centre of terminal stud shall be as per Table-I. |
| 7.11.00 | All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment. |
| 7.12.00 | The motors shall be suitable for bus transfer schemes provided on the 11kV, 3.3 kV /415V systems without any injurious effect on its life. |
| 7.13.00 | For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box. |
| 7.14.00 | 11kV and 3.3 kV motor Terminal Box shall be suitable for fault level of 750MVA for 0.12 sec and 250 MVA for 0.12 sec respectively. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds. |
| 7.15.00 | The size and number of cables (for HT and LT motors) to be intimated to the successful bidder during detailed engineering and the contractor shall provide terminal box suitable for the same. |
| 8.00.00 | The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor. |



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| | | |
|---|---|---|
| | (a) Below 110KW : 10.0 | |
| | (b) From 110 KW & upto 200 KW : 9.0 | |
| | (c) Above 200 KW & upto 1000KW : 10.0 | |
| | (d) From 1001KW & upto 4000KW : 9.0 | |
| | (e) Above 4000KW : 6 to 6.5 | |
| **10.00.00** | **TYPE TEST** | |
| 10.01.00 | **HT MOTORS** | |
| 10.01.01 | The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of Section - VII-(BPS) and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer. | |
| 10.01.02 | The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up,<br><br>instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out. | |
| 10.01.03 | In case the contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the owner for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The owner reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor. | |
| 10.01.04 | Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED"and carried out within last ten years from the date of bid opening. These reports<br><br>should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the | |

contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.

10.01.05 **LIST OF TYPE TESTS TO BE CONDUCTED**

**The following type tests shall be conducted on each type and rating of HT motor**

(a) No load saturation and loss curves upto approximately 115% of rated voltage

(b) Measurement of noise at no load.

(c) Momentary excess torque test (subject to test bed constraint).

(d) Full load test(subject to test bed constraint)

(e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load,

specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

(f) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15

(g) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

10.01.06 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for each type and rating of HT motor

(a) Degree of protection test for the enclosure followed by IR, HV and no load run test.

(b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.

10.02.00 **LT Motors**

10.02.01 LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last *ten* years from the date of bid opening.

| CLAUSE NO. | TECHNICAL REQUIREMENTS एनटीपीसी NTPC |
|---|---|
| | These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. |
| 10.02.02 | However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval. |
| 10.02.03 | **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**<br><br>**The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only**<br><br>1. Measurement of resistance of windings of stator and wound rotor.<br>2. No load test at rated voltage to determine input current power and speed<br>3. Open circuit voltage ratio of wound rotor motors ( in case of Slip ring motors)<br>4. Full load test to determine efficiency power factor and slip .<br>5. Temperature rise test .<br>6. Momentary excess torque test.<br>7. High voltage test .<br>8. Test for vibration severity of motor.<br>9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)<br>10. Test for degree of protection and<br>11. Overspeed test.<br>12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1 |
| 10.03.00 | All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price. |

| CLAUSE NO. | TECHNICAL REQUIREMENTS |
|---|---|
| 10.04.00 | The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet. |



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**TABLE - I**

**DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS**

| Motor MCR in KW | Minimum distance between centre of stud and gland plate in mm |
|---|---|
| UP to 3 KW | As per manufacturer's practice. |
| Above 3 KW - upto 7 KW | 85 |
| Above 7 KW - upto 13 KW | 115 |
| Above 13 KW - upto 24 KW | 167 |
| Above 24 KW - upto 37 KW | 196 |
| Above 37 KW - upto 55 KW | 249 |
| Above 55 KW - upto 90 KW | 277 |
| Above 90 KW - upto 125 KW | 331 |
| Above 125 KW-upto 200 KW | 203 |

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

**PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:**

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

| Motor MCR in KW | Clearance |
|---|---|
| UP to 110 KW | 10mm |
| Above 110 KW and upto 150 KW | 12.5mm |
| Above 150 KW | 19mm |

| | TITLE | SPECIFICATION NO. |
|---|---|---|
| BHEL | **LV MOTORS** | VOLUME II B |
| | | SECTION D |
| | **DATA SHEET-A** | REV NO. DATE |
| | | SHEET 1 OF 1 |

| | | | | |
|---|---|---|---|---|
| 1.0 | Design ambient temperature | | : | 50 °C |
| 2.0 | Maximum acceptable kW rating of LV motor | | : | 200 KW |
| 3.0 | Installation (Indoors/ Outdoors) | | : | As required |
| 4.0 | Details of supply system | | | |
| | a) | Rated voltage (with variation) | : | 415V ± 10%, 11/3.3kV ± 6%, |
| | b) | Rated frequency (with variation) | : | 50 Hz ± 5% |
| | c) | Combined voltage & freq. variation | : | 10% (sum of absolute values) |
| | d) | System fault level at rated voltage | : | 40 kA for 1 sec for 11kV & 3.3kV<br>45 kA for 1 sec for 415V system |
| | e) | LV System grounding | : | Solidly |
| 5.0 | Class of insulation | | : | 130(B) or better |
| 6.0 | Minimum voltage for starting (As percentage of rated voltage) | | : | 80% of rated voltage |
| 7.0 | Power cables data | | : | Details attached |
| 8.0 | Earth Conductor Size & Material | | : | Details attached |
| 9.0 | Space heater supply | | : | 240 V, 1¢ , 50 Hz |
| 10.0 | Rating up to which Single phase motor | | : | Acceptable below 0.2 kW |
| 11.0 | Locked rotor current | | | |
| | a) | Limit as percentage of FLC | : | Details as per spec attached |
| | b) | Permissible tolerance, if any | : | ±20% |
| 12.0 | Energy Efficient Motors | | : | Details as per spec attached |
| 13.0 | Additional tests | | : | As per QP |
| 14.0 | Flame-proof motor | | | |
| | a) | Enclosure suitable (As per IS:2148) | : | As per requirement |
| | b) | Classification of Hazardous area (As per IS: 5572 part-I) | : | As per requirement |
| 15.0 | Makes | | : | ABB/ Bharat Bijlee/ CGL / KEC/ NGEF/Siemens/ALSTOM (SUBJECT TO CUSTOMER APPROVAL DURING DETAILED ENGG) |

Note: **Motor name plate rating at 50°C shall have at least 10% margin over input power requirement at rated duty point unless otherwise stated in driven equipment specification**

## ELECTRICAL PORTION OF PASSENGER / SERVICE ELEVATORS AND LIFTS

| Items Description | General physical Inspection / Dimensions | Functional/ Operational Test | Burn in Test on on electronic cards | Pre-treatment in seven tank for sheet steel , Painting | Pain shade, thickness & adhesion | All Routine tests as per relevant standard |
|---|---|---|---|---|---|---|
| Electrical Motor IS 325 / IS 4722 | Y | Y | | | | Y |
| PLC (IEC 1131) | Y | Y | Y | | | Y |
| VVVF Panel | Y | Y | Y | Y | Y | Y |

Note :

1) This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed alongwith relevant supporting documents during QP finalisation.

2) Make of all major Bought Out Items will be subject to NTPC approval.

## INDUCTION MOTOR & SYNCHRONOUS MACHINE

| TESTS/CHECKS / TEMS/COMPONENTS | Visual | Dimensional | Make/Type/Rating/TC/General Physical Inspection | Mech/Chem. Properties | NDT /DP/MPI/UT | Metallography | Electrical Characteristics | Welding/Brazing(WPS/PQR) | Heat Treatment | Magnetic Characteristics | Hydrualic/Leak/Pressure Test | Thermal Characteristics | Run out | Dynamic Balancing | All tests as per IS-325/IS-4722 / 9283 | Vibration | Over speed | Tan delta, shaft voltage & polarisation index test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plates for stator frame, end shield, spider etc. | Y | Y | Y | Y | | | | | Y | | | | | | | | | |
| Shaft | Y | Y | Y | Y | Y | Y | | | Y | | | | | | | | | |
| Magnetic Material | Y | Y | Y | Y | Y | | Y | | | Y | | Y | | | | | | |
| Rotor Copper/Aluminium | Y | Y | Y | Y | | Y | Y | | Y | | | | | | | | | |
| Stator copper | Y | Y | Y | Y | | | Y | | Y | | | Y | | | | | | |
| SC Ring | Y | Y | Y | Y | Y | Y | Y | Y | Y | | | | | | | | | |
| Insulating Material | Y | | Y | Y | | | Y | | | | | Y | | | | | | |
| Tubes for Cooler | Y | Y | Y | Y | Y | | | | Y | | Y | | | | | | | |
| Sleeve Bearing | Y | Y | Y | Y | Y | | | | Y | | Y | | | | | | | |
| Stator/Rotor, Exciter Coils | Y | Y | Y | | | | Y | Y | | | | | | | | | | |
| Castings, stator frame, terminal box and bearing housing etc. | Y | Y | Y | Y | Y | | | Y | | | | | | | | | | |
| Fabrication & machining of stator, rotor, terminal box | Y | Y | | | Y | | | | Y | | | | | | | | | |
| Wound stator | Y | Y | | | | | Y | Y | | | | | | | | | | |
| Wound Exciter | Y | Y | | | | | Y | Y | | | | | | | | | | |
| Rotor complete | Y | Y | | | | | Y | | | | | | Y | Y | | | | |
| Exciter, Stator, Rotor, Terminal Box assembly | Y | Y | | | | | Y | | | | | | | | | | | |
| Accessories, RTD, BTD,CT, Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc. | Y | Y | Y | | | | | | | | | | | | | | | |
| Motor (IS 325 / 4722/ 9283) | Y | Y | Y | | | | | | | | | | | | Y | Y | Y | Y1 |

Note: 1. This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating the practices & Procedure followed along with relevant supporting documents during QP finalization. However, No QP for LT motor up to 50KW.
2. Makes of all major bought out items will be subject to NTPC approval.
Y1 = for HT Motor / Machines only.

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# L.T. POWER CABLES

## LT POWER CABLES

**1.00.00 CODES & STANDARDS**

1.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

| | |
|---|---|
| IS :1554 - I | PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V. |
| IS : 3961 | Recommended current ratings for cables |
| IS : 3975 | Low carbon galvanised steel wires, formed wires and tapes for armouring of cables. |
| IS : 5831 | PVC insulation and sheath of electrical cables. |
| IS:7098 (Part -I) | Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V. |
| IS : 8130 | Conductors for insulated electrical cables and flexible cords. |
| IS : 10418 | Specification for drums for electric cables. |
| IS : 10810 | Methods of tests for cables. |
| ASTM-D -2843 | Standard test method for density of smoke from the burning or decomposition of plastics. |
| IEC-754 (Part-I) | Tests on gases evolved during combustion of electric cables. |
| IEC-332 | Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B). |



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**2.00.00 TECHNICAL REQUIREMENTS**

2.01.00 The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.

2.02.00 Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

2.03.00 Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be stranded.

2.04.00 XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

2.05.00 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.

2.06.00 For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanised steel as follows :

| Calculated nominal dia. of cable under armour | Size and Type of armour |
|---|---|
| Upto 13 mm | 1.4mm dia GS wire |
| Above 13 & upto 25mm | 0.8 mm thick GS formed wire / 1.6 mm dia GS wire |
| Above 25 & upto 40 mm | 0.8mm thick GS formed wire / 2.0mm dia GS wire |
| Above 40 & upto 55mm | 1.4 mm thick GS formed wire /2.5mm dia GS wire |
| Above 55 & upto 70 mm | 1.4mm thick GS formed wire / 3.15mm dia GS wire |
| Above 70mm | 1.4 mm thick GS formed wire / 4.0 mm dia GS wire |

| CLAUSE NO. | TECHNICAL REQUIREMENTS | एनटीपीसी NTPC |
|---|---|---|
| 2.06.01 | The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm $mm^2$ per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel. | |
| 2.06.02 | 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 wire / formed wire. The minimum area of coverage of armouring 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 G.S.wire/ formed wire. | |
| 2.07.00 | Outer sheath shall be of PVC as per IS: 5831 & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.<br><br>(a.) Oxygen index of min. 29 (as per IS 10810 Part-58).<br><br>(b.) Acid gas emission of max. 20% (as per IEC-754-I).<br><br>(c.) Smoke density rating shall not be more than 60 % (as per ASTMD-2843). | |
| 2.08.00 | Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:<br><br>1 core - Red, Black, Yellow or Blue<br><br>2 core - Red & Black<br><br>3 core - Red, Yellow & Blue<br><br>4 core - Red, Yellow, Blue and Black | |
| 2.09.00 | For reduced neutral conductors, the core shall be black. | |
| 2.10.00 | In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.<br><br>(a.) Cable size and voltage grade - To be embossed<br><br>(b.) Word 'FRLS' at every 5 metre - To be embossed<br><br>(c.) Sequential marking of length of the cable in metres at every one metre -To be embossed / printed<br><br>The embossing shall be progressive, automatic, in line and marking shall be legible and indelible. | |



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| CLAUSE NO. | TECHNICAL REQUIREMENTS एनटीपीसी NTPC |
|---|---|
| 2.11.00 | All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3. |
| 2.12.00 | Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum, over the declared value in the technical data sheets. |
| 2.13.00 | In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable. |
| **3.00.00** | **Cable selection & sizing** |
| 3.01.00 | LT Power cables shall be sized based on the following considerations:<br>(a) Rated current of the equipment<br>(b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage<br>(c) Short circuit withstand capability<br>This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse.For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.<br>(d) The minimum conductor size shall be 6 sqmm for aluminium conductor cables and 2.5 sqmm for copper conductor cables. The constructional details of copper conductor cables shall be same as indicated for copper control cable. |
| 302.00 | Derating Factors<br>Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:<br>a) Variation in ambient temperature for cables laid in air<br>b) Grouping of cables<br>c) Variation in ground temperature and soil resistivity for buried cables. |
| 3.03.00 | Cable lengths shall be considered in such a way that straight through cable joints are avoided. |
| 3.04.00 | Cables shall be armoured type if laid in switchyard area or directly buried. |



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3.05.00 All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated and preferable sizes are 1Cx150, 1Cx300, 1Cx630, 3Cx150 & 3Cx240 sq.mm.

**4.00.00 CONSTRUCTIONAL FEATURES**

(a.) **1.1 KV grade XLPE power cables** shall have compacted aluminium conductor, XLPE insulated, PVC inner sheathed (as applicable), armoured/ unarmoured, FRLS PVC outer sheathed conforming to IS:7098. (Part-I).

(b.) **1.1KV grade PVC power cables** shall have aluminium conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed, armoured/ unarmoured, FRLS PVC outer sheathed conforming to IS:1554 (Part-I).

**5.00.00 CABLE DRUMS**

(a) Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

(b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stencilled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

(c) The standard drum length for power cables shall not be less than 500 meters. The length per drum shall be subjected to a maximum tolerance of +/- 5% of the standard drum length. The Employer shall have the option of rejecting cable drum with shorter lengths. For each size, the variance of total quantity, adding all the supplied drum lengths, from the ordered quantity, shall not exceed +/- 2%.

**5.00.00 TYPE TESTS**

5.01.00 General

All equipments to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the



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date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.

All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

5.02.00 **Type Tests**

5.02.01 The reports for the following type tests shall be submitted for one size each of LT XLPE and LT PVC Power cables. Size shall be decided by the employer during detailed engineering :

| S.No. | Type test | Remarks |
|---|---|---|
| | **For Conductor** | |
| 1. | Resistance test | |
| 2. | Tensile test | For circular non-compacted conductors only |
| 3. | Wrapping test | For circular non-compacted only |
| | **For Armour Wires/ Formed Wires** | |
| 4. | Measurement of Dimensions | |
| 5. | Tensile Test | |
| 6. | Elongation test | |

| | | |
|---|---|---|
| 7. | Torsion test | For round wires only |
| 8. | Wrapping test | For aluminium wires / formed wires only. |
| 9. | Resistance test | |
| 10(a) | Mass of zinc coating test | For GS Formed wires/wires only |
| 10(b) | Uniformity of zinc coating | For GS Formed wires /wires only |
| 11. | Adhesion test | For GS Formed wires/wires only |
| | **For PVC/XLPE insulation & PVC Sheath** | |
| 12. | Test for thickness | |
| 13. | Tensile strength & elongation tests | before ageing and after ageing |
| 14. | Ageing in air oven | |
| 15. | Loss of mass test | For PVC insulation and sheath only |
| 16. | Hot deformation test | For PVC insulation and sheath only |
| 17. | Heat shock test | For PVC insulation and sheath only |
| 18. | Shrinkage test | |
| 19. | Thermal stability test | For PVC insulation and sheath only |
| 20. | Hot set test | For XLPE insulation only |
| 21. | Water absorption test | For XLPE insulation only |
| 22. | Oxygen index test | For outer sheath only |
| 23. | Smoke density test | For outer sheath only |

| CLAUSE NO. | TECHNICAL REQUIREMENTS | | |
|---|---|---|---|
| | 24. | Acid gas generation test | For outer sheath only |
| | | **For completed cables** | |
| | 25. | Insulation resistance test | |
| | | (Volume resistivity method) | |
| | 26. | High voltage test | |
| | 27. | Flammability test as per IEC-332 Part-3 (Category-B) | |
| 5.02.02 | **Acceptance Tests** (as per QA table) | | |
| 5.02.03 | **Routine Tests** (as per QA table) | | |

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NTPC

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# L.T. CONTROL CABLES

| | |
|---|---|
| LARA SUPER THERMAL POWER PROJECT, STAGE-I (2X800 MW)<br>DARLIPALI SUPER THERMAL POWER PROJECT, STAGE-I (2X800 MW)<br>GAJMARA SUPER THERMAL POWER PROJECT, STAGE-I (2X800 MW)<br>KUDGI SUPER THERMAL POWER PROJECT, STAGE-I (3X800 MW)<br>STEAM TURBINE GENERATOR PACKAGE | TECHNICAL SPECIFICATION<br>SECTION-VI<br>PART-B |

## LT CONTROL CABLES

**1.00.00 CODES & STANDARDS**

1.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes :

| | |
|---|---|
| IS :1554 - I | PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V. |
| IS : 3961 | Recommended current ratings for cables |
| IS : 3975 | Low carbon galvanised steel wires, formed wire and tapes for armouring of cables. |
| IS : 4905 | Methods for random sampling. |
| IS : 5831 | PVC insulation and sheath of electrical cables. |
| IS : 8130 | Conductors for insulated electrical cables and flexible cords. |
| IS : 10418 | Specification for drums for electric cables. |
| IS : 10810 | Methods of tests for cables. |
| ASTM-D -2843 | Standard test method for density of smoke from the burning or decomposition of plastics. |
| IEC-754 (Part-I) | Test on gases evolved during combustion of electric cables. |
| IEC -332 | Tests on Electric cables under fire conditions<br>Part-3 : Tests on bunched wires or cables (category - B) |

**2.00.00 TECHNICAL REQUIREMENTS**

2.01.00 The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground burried installation with chances of flooding by water.

| CLAUSE NO. | TECHNICAL REQUIREMENTS (एनटीपीसी NTPC) |
|---|---|
| 2.02.00 | Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification. |
| 2.03.00 | Conductor of control cables shall be made of multi stranded, plain annealed copper. |
| 2.04.00 | PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C. |
| 2.05.00 | 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. |
| 2.06.00 | For multicore armoured cables, the armouring shall be of galvanised steel as follows :- |

| | **Calculated nominal dia of cable under armour** | **Size and Type of armour** |
|---|---|---|
| 1) | Upto 13 mm | 1.4mm dia GS wire |
| 2) | Above 13 upto 25 mm | 0.8 mm thick GS formed wire / 1.6 mm dia GS wire |
| 3) | Above 25 upto 40 mm | 0.8mm thick GS formed wire / 2.0mm dia GS wire |
| 4) | Above 40 upto 55mm | 1.4 mm thick GS formed wire/ 2.5mm dia GS wire |
| 5) | Above 55 upto 70 mm | 1.4mm thick GS formed wire / 3.15mm dia GS wire |
| 6) | Above 70mm | 1.4 mm thick GS formed wire / 4.0 mm dia GS wire |

The gap between armour wire / formed wire shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring 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.

| | |
|---|---|
| 2.07.00 | Outer sheath shall be of PVC(grade as applicable) and grey in colour . In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties. |

| | |
|---|---|
| | (a) Oxygen index of min. 29 (As per IS:10810 (part-58)) |
| | (b) Acid gas emission of max. 20% (As per IEC-754-I). |
| | (c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843. |
| 2.08.00 | Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.<br>1 core - Red, Black, Yellow or Blue<br>2 core - Red & Black<br>3 core - Red, Yellow & Blue<br>4 core - Red, Yellow, Blue and Black<br>5 core - Red, Yellow, Blue, Black and Grey |
| 2.09.00 | For cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. 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 under neath 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 between consecuture numbers shall not exceed 50 mm. |
| 2.10.00 | In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath :<br>(a) Cable size and voltage grade - To be embossed<br>(b) Word 'FRLS' at every 5 metre - To be embossed<br>(c) Sequential marking of length of the cable in metres at every one metre. - To be embossed / printed.<br>The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible. |

| CLAUSE NO. | TECHNICAL REQUIREMENTS एनटीपीसी NTPC |
|---|---|
| 2.11.00 | All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part -3. |
| 2.12.00 | Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum over the declared value in the technical data sheets. |
| 2.13.00 | In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable. |
| 2.14.00 | **Cable selection & sizing** |
| 2.14.01 | LT Control cables shall be sized based on the following considerations:<br>(a) Rated current of the equipment<br>(b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage<br>(c) Short circuit withstand capability<br>This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse.For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time.<br>(d) The minimum size of conductor shall be 1.5 sqmm |
| 2.14.02 | Derating Factors<br>Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:<br>a) Variation in ambient temperature for cables laid in air<br>b) Grouping of cables<br>c) Variation in ground temperature and soil resistivity for buried cables. |
| 2.14.03 | Cable lengths shall be considered in such a way that straight through cable joints are avoided. |
| 2.14.04 | Cables shall be armoured type if laid in switchyard area or directly buried. |



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| CLAUSE NO. | TECHNICAL REQUIREMENTS | एनटीपीसी NTPC |
|---|---|---|
| **3.00.00** | **CONSTRUCTIONAL FEATURES** | |
| 3.01.00 | **1.1 KV Grade Control Cables**<br><br>Control Cables shall have stranded copper conductor multicore PVC insulated, PVC inner-sheathed, armoured / unarmoured, PVC outer-sheathed conforming to IS:1554. (Part-I). | |
| 3.02.00 | **Cable Drums**<br><br>(a) Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS : 10418.<br><br>(b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stencilled on both the sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.<br><br>(c.) The standard drum length for control cables shall not be less than 1000 metres. The length per drum shall be subjected to a maximum tolerance of +/- 5% of the standard drum length. The Employer shall have the option of rejecting cable drums with shorter lengths. For each size, the variance of total quantity, adding all the supplied drum lengths, from the ordered quantity, shall not exceed +/- 2%. | |
| **4.00.00** | **TESTS** | |
| 4.01.00 | **GENERAL**<br><br>All equipments to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. | |



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| | |
|---|---|
| | However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval.<br><br>All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.<br><br>The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet. |
| 4.02.00 | **TYPE TESTS:** |
| 4.02.01 | The Type tests reports for the following shall be submitted for one size of LT control cable : |

| S. No. | Type Test | Remarks |
|---|---|---|
| a) | **For Conductor** | |
| 1. | Resistance test | |
| b) | **For Armour Wires / Formed wires** | |
| 2. | Measurement of Dimensions | |
| 3. | Tensile Test | |
| 4. | Elongation test | |
| 5. | Torsion test | For round wire only |
| 6. | Winding test | For Formed wires |
| 7. | Resistance test | |
| 8. | Zinc Coating test | For G.S. conductors only. |
| c) | **For PVC insulation & PVC Sheath** | |
| 9. | Test for thickness | |



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| | | | |
|---|---|---|---|
| | 10. | Tensile strength and elongation test before ageing and after ageing | |
| | 11. | Ageing in air oven | |
| | 12. | Loss of mass test | For PVC insulation and sheath only |
| | 13. | Hot deformation test | For PVC insulation and sheath only |
| | 14. | Heat shock test | For PVC insulation and sheath only |
| | 15. | Shrinkage test | |
| | 16. | Thermal stability test | For PVC insulation and sheath only |
| | 17. | Oxygen index test | For outer sheath only |
| | 18. | Smoke density test | For outer sheath only |
| | 19. | Acid gas generation test | For outer sheath only |
| | d) | **For completed cables** | |
| | 20. | Insulation resistance test (Volume resistivity method) | |
| | 21. | High voltage test | |
| | 23. | Flammability test as per IEC - 332 Part-3 (Category-B) | |
| 4.02.02 | **Acceptance Tests** (as per QA table) | | |
| 4.03.00 | **Routine Tests** (as per QA table) | | |



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# LT POWER CABLES

| | |
|---|---|
| LARA STPP, STAGE-I (2X800 MW),<br>DARLIPALLI STPP, STAGE-I (2X800MW),<br>GAJMARA STPP, STAGE-I (2X800 MW),<br>KUDGI STPP, STAGE-I (3X800 MW)<br>STEAM TURBINE GENERATOR PACKAGE | TECHNICAL SPECIFICATION<br>SECTION-VI<br>PART-B |

# L.T. POWER CABLES
# (1.1 KV PVC & XLPE CABLES)

| Attributes / Characteristics<br>Item / Components / Sub System Assembly | Make, Rating, Type & TC | Dimension/surface finish | Mechanical Properties | Chemical Composition | Electrical Properties | Spark Test | Hot set test (XLPE) | Lay length / Sequence | Armour coverage, Cross over, looseness, Gap between two armour wire/strip | Sequential marking/surface finish /cable length | Tensile strength, elongation before & after ageing of insulation & outer sheath | Thermal Stability of insulation and outer sheath * | Anti ternite treatment on wooden drums | Constructional / requirement as per NTPC Spec. | Routine and acceptance test as per Relevant Standard and NTPC specification | FRLS Test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum (IS-8130) | Y | Y | Y | Y | Y | | | | | | | | | | | |
| PVC Compound (IS-5831) | Y | | Y | | Y | | | | | | Y | | | | | |
| XLPE Compound(IS-7098 Part-I) | Y | | Y | | Y | | Y | | | | Y | | | | | |
| FRLS PVC Compound(IS-5831) ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-I | Y | | Y | | | | | | | | Y | | | | | |
| Armour wire/strip (IS-3975) | Y | Y | Y | | | | | | | | | | | | | |
| Insulated Core | | Y | | | | Y | Y | | | | | Y | | | | |
| Laid up core | | Y | | | | | | Y | | | | | | | | |
| PVC Inner sheath | | Y | | | | | | | | | | | | | | |
| Armouring | | Y | | | | | | | Y | | | | | | | |
| Outer sheath | | Y | | | | | | | | Y | Y | Y | | | | Y |
| Finish cable (IS-1554 & 7098 – Part-1)<br>ASTM-D-2843/ IS 10810 (Part- -58)<br>IEC-754 Part-I<br>Swedish Chimney SS 4241475 for (F3 category)<br>Flammability test IEC-332 Part –3 Cat-B | Y | Y | | | | | | | Y | Y | Y | Y | | Y | Y | Y |
| Wooden drum (IS-10418) / Steel drum | | Y | | | | | | | | | | | Y | | | |

Note: This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the practice and procedure along with relevant supporting documents.

* 2. Not applicable for XLPE insulation

| | |
|---|---|
| | **ROUTINE TESTS**<br><br>**Routine tests shall be carried out on each drum of finished cables for all types & sizes.**<br><br>**Following shall constitute routine tests:** |
| 1) | Conductor Resistance test |
| 2) | High voltage test at room temperature |

| | | |
|---|---|---|
| | **ACCEPTANCE TESTS** | |
| | **Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1 & IS 7098 Part-I** | |
| **A)** | **For Conductor** | |
| 1) | Annealing test | For copper conductor only |
| 2) | Tensile test | For aluminium conductor only |
| 3) | Wrapping test | For aluminium conductor only |
| 4) | Resistance test | |
| **B)** | **For Armour Wires / Formed Wires (If applicable**) | |
| 1) | Measurement of Dimensions | |
| 2) | Tensile Tests | |
| 3) | Elongation Test | |
| 4) | Torsion Test | For Round wires only |
| 5) | Wrapping Test | |
| 6) | Resistance Test | |
| 7) | Mass of Zinc coating test | For G S wires / Formed wires only |

| | |
|---|---|
| 8) | Uniformity of Zinc coating For G S wires / Formed wires only |
| 9) | Adhesion test For G S wires / Formed wires only |
| 10) | Freedom from defects |
| **C)** | **For PVC / XLPE insulation & PVC Sheath** |
| 1) | Test for thickness |
| 2) | Hot set test For XLPE insulation only |
| 3) | Tensile strength & Elongation before ageing |
| **D)** | **For completed cables** |
| 1) | Insulation resistance test (Volume resistivity method) |
| 2) | High voltage test **at room temperature** |
| **E)** | **Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-** |
| 1) | Tensile strength & elongation after ageing **on PVC / XLPE insulation and PVC outer sheath** |
| 2) | Thermal stability test **on PVC insulation and outer sheath** |
| 3) | Oxygen index test **on outer sheath** |
| 4) | Smoke density rating test **on outer sheath as per ASTM –D 2843** |
| 5) | Acid gas generation test **on outer sheath as per IEC – 754 (Part 1)** |
| 6) | Flammability test as per IEC-332 - Part- 3 (Category- B) **on completed cable** |
| 7) | Fire resistance test as per SS 4241475 (F3 Category) **on completed cable** |
| **F)** | **Following tests shall be carried on one length of each size of offered lot:** |
| 1) | Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires |

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# LT CONTROL CABLES

| | |
|---|---|
| LARA STPP, STAGE-I (2X800 MW),<br>DARLIPALLI STPP, STAGE-I (2X800MW),<br>GAJMARA STPP, STAGE-I (2X800 MW),<br>KUDGI STPP, STAGE-I (3X800 MW)<br>STEAM TURBINE GENERATOR PACKAGE | TECHNICAL SPECIFICATION<br>SECTION-VI<br>PART-B |

## L.T. CONTROL CABLES
## (1.1 KV PVC CABLES)

| Attributes / Characteristics / Item / Components / Sub System Assembly | Make, Type, Rating, T.C | Dimension/surface finish | Mechanical Properties | Chemical Composition | Electrical Properties | Spark Test | Lay length/Sequence | Armour coverage, cross over, looseness, gap between two armour wire | Sequential marking/surface finish/cable length | Tensile strength, elongation before & after ageing of insulation &outer sheath | Thermal stability of insulation and outer sheath | Anti termite treatment on wooden drums | Constructional feature as per NTPC [illegible] | Routine & Acceptance test as per relevant standard & page 2 & 3 of this table | FRLS Test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper Conductor (IS-8130) | Y | Y | Y | Y | Y | | | | | | | | | | |
| PVC Compound (IS-5831) | Y | | Y | | Y | | | | | Y | | | | | |
| FRLS PVC Compound IS-5831 ASTM-D-2843/ IS 10810 (Part-58 ) IEC-754 Part-1 | Y | | Y | | | | | | | Y | | | | | Y |
| Armour wire/strip (IS-3975) | Y | Y | Y | | | | | | | | | | | | |
| Insulated Core | | Y | | | | Y | Y | | | | Y | | | | |
| Laid up core | | Y | | | | | Y | | | | | | | | |
| PVC Inner sheath | | Y | | | | | | | | | | | | | |
| Armouring | | Y | | | | | | Y | | | | | | | |
| Outer sheath | | Y | | | | | | | Y | Y | Y | | | | Y |
| Finish cable (IS-1554-1) ASTM-D-2843/ IS 10810 (Part-58) IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475 (F3 category) Flammability test IEC-332 Part-3 Cat-B | Y | Y | | | | | | Y | Y | Y | Y | | Y | Y | Y |
| Wooden drum (IS : 10418) / Steel drum | | Y | | | | | | | | | | Y | | | |

- 1.Note : This is an indicative list of test/checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents.

**CONTROL CABLE**

**ROUTINE TESTS**

**Routine tests shall be carried out on each drum of finished cables for all types & sizes.**

**Following shall constitute routine tests:**

1) Conductor Resistance test

2) High voltage test at room temperature

**ACCEPTANCE TESTS**

**Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1**

**A) For Conductor**

1) Annealing test — For copper conductor only

2) Resistance test

**B) For Armour Wires / Formed Wires ( If applicable )**

1) Measurement of Dimensions

2) Tensile Tests

3) Elongation Test

4) Torsion Test — For Round wires only

5) Wrapping Test

6) Resistance Test

7) Mass of Zinc coating test — For G S wires / Formed wires only

8) Uniformity of Zinc coating — For G S wires / Formed wires only

9) Adhesion test — For G S wires / Formed wires only

10) Freedom from defects

| | |
|---|---|
| **C)** | **For PVC insulation & PVC Sheath** |
| 1) | Test for thickness |
| 2) | Tensile strength & Elongation before ageing |
| **D)** | **For completed cables** |
| 1) | Insulation resistance test ( Volume resistivity method ) |
| 2) | High voltage test **at room temperature** |
| **E)** | **Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-** |
| 1) | Tensile strength & elongation after ageing **on PVC insulation and PVC outer sheath** |
| 2) | Thermal stability test **on PVC insulation and outer sheath** |
| 3) | Oxygen index test **on outer sheath** |
| 4) | Smoke density rating test **on outer sheath as per ASTM –D 2843** |
| 5) | Acid gas generation test **on outer sheath as per IEC – 754 (Part 1)** |
| 6) | Flammability test as per IEC-332 - Part- 3 ( Category- B ) **on completed cable** |
| 7) | Fire resistance test as per SS 4241475 (F3 Category ) **on completed cable** |
| **F)** | **Following tests shall be carried on one length of each size of offered lot:** |
| 1) | Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires |

# SECTION – VI

# PART – B

# SUB–SECTION – IIIC - 07

# INSTRUMENTATION AND POWER SUPPLY CABLES

## INSTRUMENTATION AND POWER SUPPLY CABLE

**1.00.00 INSTRUMENTATION CABLE, POWER SUPPLY CABLE, INTERNAL WIRING AND ELECTRICAL FIELD CONSTRUCTION MATERIAL**

1.01.00 **General Requirements**

1.01.01 All cables including special cables, internal wiring and electrical field construction material shall conform to this specification, Employer approved detail engineering drawings & documents and the latest edition of the relevant standards & guidelines. The Bidder shall furnish all material and services required for the completeness of the work identified in his scope as per this specification.

1.01.02 The Contractor shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under Contractor's scope as illustrated in the enclosed Drg. No. 0000-110-POI-A-021 and ensuring completeness of the control system.

1.01.03 Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Contractor.

1.01.04 Other type of cables like fiber optic/co-axial cables for system bus, cables for connection of peripherals etc. (under Contractor's scope) are also to be furnished by the Contractor.

1.01.05 Contractor shall supply all cable erection and laying hardware from the main trunk routes like branch cable trays/sub-trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.

1.01.06 Wherever the quantity has been defined as on as required basis, the same are to be furnished by contractor on as required basis within his quoted lump sump price without any further cost implication to the Employer.

**2.00.00 Specification of Instrumentation cable**

2.01.00 Common Requirements

| S. No. | Property | Requirement |
|---|---|---|
| 1 | Voltage grade | 225 V (peak value) |
| 2. | Codes and standard | All instrumentation cables shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS- |

| S. No. | Property | Requirement |
|---|---|---|
| | | 10810 (latest editions) and their amendments read along with this specification. |
| 3. | Continuous operation suitability | At 70 deg. C for all types of cables, while 205 Deg C for Type-C cables. |
| 4. | Progressive automatic on-line sequential marking of length in meters | To be provided at every one meter on outer sheath. |
| 5. | Marking to read 'FRLS' | To be provided at every 5 meters on outer sheath except for Type-C cable. |
| 6. | Allowable Tolerance on overall diameter | +/- 2 mm (maximum) over the declared value in data sheet |
| 7. | Variation in diameter | Not more than 1.0 mm throughout the length of cable. |
| 8 | Ovality at any cross-section | Not more than 1.0 mm |
| 9 | Others | a) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided.<br>b) Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground-buried installation<br>c) Repaired cables shall not be acceptable. |

2.02.00 Specific Requirements

| Specification Requirements | Type-A cable | Type-B cable | Type F & G cable | Type-C cable |
|---|---|---|---|---|
| **A. Conductors** | | | | |
| Cross section area | 0.5 sq. mm | | | |
| Conductor material | ANSI type KX | ANSI type SX | High conductivity Annealed bare copper | ANSI type KX |
| Colour code | Yellow-Red | Black-Red | As per VDE-815 | Yellow-Red |
| Conductor Grade | As per ANSI MC 96.1 | | Electrolytic | As per ANSI MC 96.1 |
| No & dia of strands | 7x0.3 mm (nom) | | | |
| No. of Pairs | 2 | 2 | 4,8,12,16,24,48 | 2 |
| Max. conductor resistance per Km (in ohm) at 20 deg. C | As per ANSI MC 96.1 | | 73.4 (loop) | As per ANSI MC 96.1 |
| Reference Standard | As per ANSI MC 96.1 | | VDE 0815 | As per ANSI MC 96.1 |
| **B. Insulation** | | | | |
| Material | PVC type YI 3 | | | Teflon (i.e. extruded FEP) |
| Thickness in mm (Min/Nom/Max) | 0.25/0.3/0.35 | | | 0.4/0.50 |
| Volume Resistivity (Min) in ohm-cm | $1 \times 10^{14}$ at 20 deg. C & $1 \times 10^{11}$ at 70 deg. C. | | | --- |

| | | | | |
|---|---|---|---|---|
| Voltage Rating | 225 V peak operating voltage | | | |
| Reference Standard | VDE 0207 Part 4 | | | VDE 0207 Part 6 & ASTMD 2116. |
| Core diameter above insulation | Suitable for cage clamp connector | | | |
| **C. Pairing & Twisting** | | | | |
| Max. lay of pairs (mm) | 50 | | | |
| Single layer of Polyester tape on each pair provided | Numbered tape | Yes | N.A. | |
| Unit formation of four pairs with printing of no. of Unit provided | N.A. | Yes | N.A. | |
| Conductor /pair identification as per VDE0815 | N.A. | To be provided (color coding attached). | N.A. | |
| **D. Shielding** | | | | |
| Type of shielding | Al-Mylar tape | | | |
| Individual pair shielding | No | To be provided for F-type cable | No | |
| Minimum thickness of Individual pair shielding | No | 28 micron | No | |
| Overall cable assembly shielding | To be provided | | | |
| Minimum thickness of | 55 micron | | | |

| | | | |
|---|---|---|---|
| Overall cable assembly shielding | | | |
| Shielding coverage | 100% with at least 20% overlap | | |
| Drain wire provided for individual shield | N.A. | Yes (for F-type) 7-strand 20 AWG (0.51 $mm^2$) annealed Tin coated copper | N.A. |
| Drain wire provided for overall shield | Yes. 7-strand 20 AWG (0.51 $mm^2$) annealed Tin coated copper | | |
| **E. FILLERS** | | | |
| Non-hygroscopic, flame retardant | To be provided | | |
| **F. Outer Sheath** | | | |
| Material | Extruded PVC compound YM1 with FRLS properties | | Teflon (i.e. extruded FRP) |
| Minimum Thickness at any point | 1.8 mm | | 0.4 mm |
| Nominal Thickness at any point | >1.8 mm | | 0.5 mm |
| Color | Blue | | |
| Resistant to water, fungus, termite & rodent attack | Required | | |
| Oxygen index as per ASTMD-2863 | not less than 29% | | N.A. |

| | | | |
|---|---|---|---|
| Temperature index as per ASTMD-2863 | not less than 250 deg.C | | N.A. |
| acid gas generation by weight as per IEC-60754-1 | Maximum 20% | | N.A. |
| Smoke Density Rating as per ASTMD-2843 | Maximum 60%<br><br>(defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843) | | N.A. |
| Reference standard | VDE207 Part 5 | | VDE207 Part 6<br>&<br><br>ASTM D2116 |
| **G. Electrical Parameters** | | | |
| MUTUAL CAPACITANCE BETWEEN CONDUCTORS AT 0.8 KHZ (MAX.) | 200 nF/km | 120 nF/km for F type<br><br>100 nF/km for G-type | 200 nF/km |
| INSULATION RESISTANCE (MIN) | 100 M Ohm/Km | | |
| CROSS TALK FIGURE (MIN.) AT 0.8 KHZ | 60 Db | 60 dB | N.A. |
| CHARACTERISTIC IMPEDANCE (MAX) AT 1 KHZ | N.A. | 320 ohm for F-type<br><br>340 ohm for G-type | N.A. |
| ATTENUATION | N.A. | 1.2 db/km | N.A. |

| | | | | |
|---|---|---|---|---|
| FIGURE AT 1 KHZ (MAX) | | | | |
| **H. Complete Cable** | | | | |
| Complete Cable assembly | Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3. | | | N.A. |
| Flammability | Shall pass flammability as per IEEE-383 read in conjunction to this specification | | | N.A. |
| **I. Accessories** | | | | |
| Cable accessories of flame retardant quality. | Yes. (Accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc.) | | | |
| **J. Tests** | | | | |
| Routine & Acceptance tests | Refer sub-section IIIE | | | |
| Type tests | Refer sub-section-CNI TYPE TEST | | | |
| **K Cable Drum** | | | | |
| Type | Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum. | | | |
| Outermost layer covered with waterproof paper | Yes | | | |
| Painting | Entire surface to be painted | | | |
| Length | 1000 m ± 5% for up to & including 12 pairs<br>500 m ± 5% for above12 pairs | | | |

**3.00.00** **SPECIFICATION OF OPTICAL FIBER CABLES (OFC)**

3.01.00 Optic Fiber cable shall be 4/8/12 core, galvanised corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or

| | |
|---|---|
| | multi mode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micrometer and 125 +/- 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath. |
| 3.02.00 | The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum& crush resistance 4000 N minimum. The operating temperature shall be –20 deg. C to 70 deg.C |
| *3.03.00* | All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards. |
| 3.04.00 | Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fibre cables. |
| 3.05.00 | Cables shall be suitable for laying in conduits, ducts, trenches, racks and under ground buried installation. |
| 3.06.00 | Spliced / Repaired cables are not acceptable. |
| 3.07.00 | Penetration of water resistance and impact resistance shall be as per IEC standard. |
| **4.00.00** | **SPCIFICATION OF POWER SUPPLY CABLES** |
| | Refer relevant subsections of this specification. |
| **5.00.00** | **INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY** |
| | The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned in the given Table A. |

TABLE A: CABLE TERMINATION TO BE FOLLOWED

| Application | | Type Of Termination | | Type Of Cable |
|---|---|---|---|---|
| FROM (A) | TO (B) | END A | END B | |
| Valves/dampers drives (Integral Junction box) | Marshalling cubicle/ Marshalling cum termination Cubicle/local group JB | Plug in connector | Posts mount cage clamp type. | G |
| Transmitters, Process Actuated switches mounted in LIE/LIR | Integral Junction box of LIE/LIR | Plug in connector | Cage clamp (Rail mount) type. | F,G |
| RTD heads | Local junction box | Plug in connector | Cage clamp (Rail mount) type. | F |
| Thermocouple | CJC Box (if applicable) | Plug in connector | Cage clamp (Rail mount) type. | A,B,C* |
| Other Field Mounted Instrument | Local JB/Group JB | Plug in connector | Screwed, Cage clamp (Rail mount) type | F,G |
| RTD | Temperature transmitter | Plug in connector | Screwed, Cage clamp type | F |
| Thermocouple | Temperature transmitter | Plug in connector | Screwed, Cage clamp type | A,B,C* |